C68-3199

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~~CONFIDENTIAL~~

Surveyor Project Review (u)

27 -- 28 August 1963

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA

~~CONFIDENTIAL~~

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SURVEYOR PROJECT REVIEW

27 and 28 August 1963

CONTENTS

1. Launch Vehicle Status - C. Wentworth, LeRC pp 4 - 20

Current vehicle status

Performance - operational vehicles

Contract status and funding

Surveyor peculiars status

JOCT and CST

Program plan

2. DSIF Status - R. Z. Toukdarian pp 21 - 26

Program plan

S-band equipment status

3. SFOF Description and Review - M. Johnson pp 27 - 31

SFOC description

Current SFOF plan

Surveyor mission training and operations planning

Ground video processing system status

Building 202 visit and demonstration

4. Surveyor Scientific Review - H. Lawrence pp 32 - 57
- M. Molloy
- E. Chandler
- D. LeCroissette

A. Over-all Science Program 32

Payload redirection

Schedule constraints

Contents (Continued)

Resource constraints

Non-payload instrument status

Mission operations

Experimenter meeting

Experimenter agreement

B. System Activities 46

Instrument integration

Data handling

C. Status of Experiments 47

Alpha scattering

Seismometer

Surface sampler

T. V.

Micrometeorite detector

Touchdown dynamics

Field trip film

5. Spacecraft System Status - SPO Staff pp 58 - 125

Current development plan and status	58
Review of T-2 and T-21 test plans	74
HAC Q.A. plan and status	81
HAC reliability plan and status	90
Review of propulsion subsystems	98
Current payload outlook, including C.O. 18, Amend. 1	111
Resources review - HAC/JPL	112
Mod. 6 and Mod. 15 comparative analysis	119
AMR facilities status	123
FY-64 funding/program plan discussion	124

PREFACE

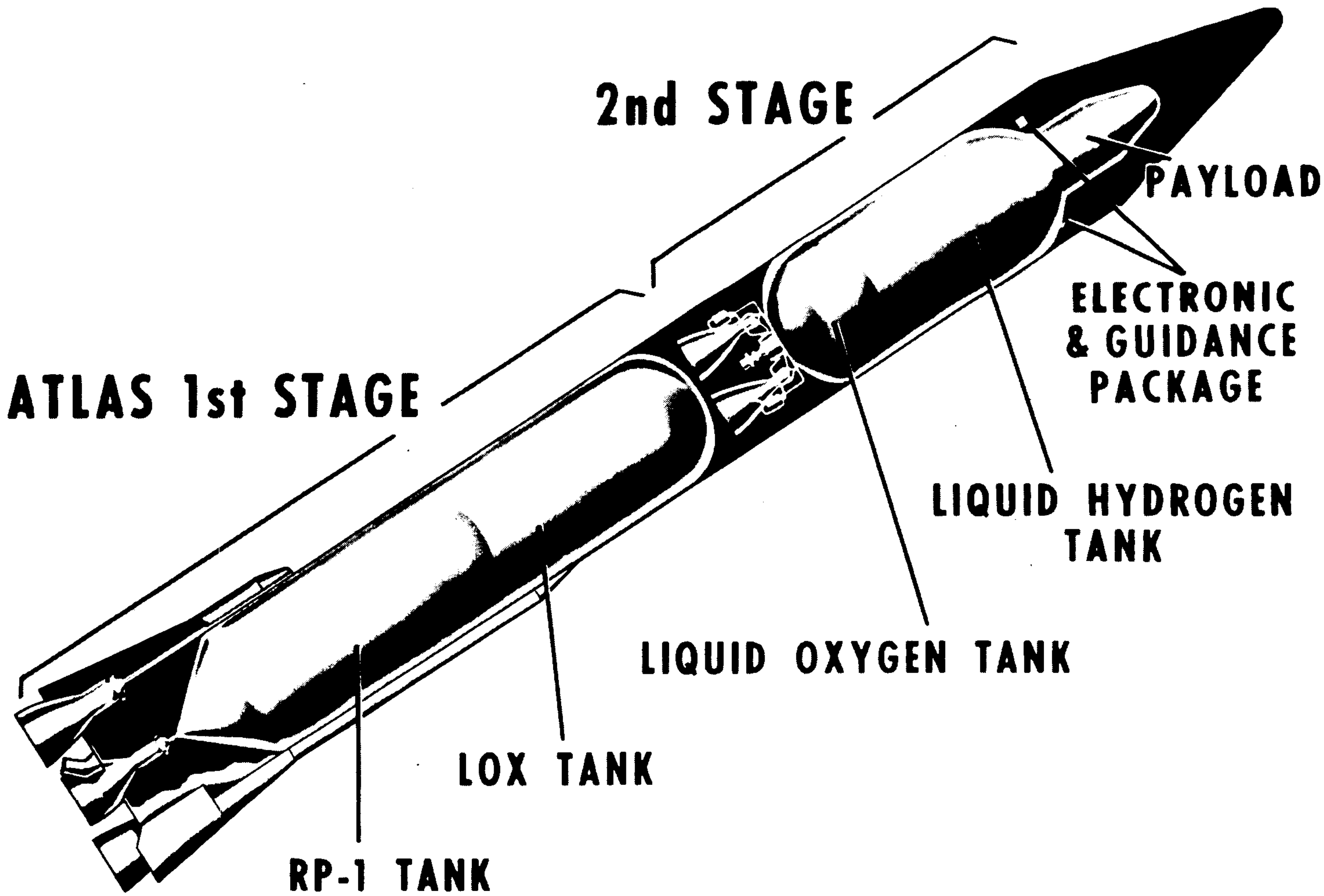
The Quarterly Surveyor Project Review was conducted at JPL on 27 and 28 August 1963 for members of the NASA Office of Space Sciences and JPL senior management. The Review was presented by representatives of the Centaur Project, the DSIF, and the SFOF, and members of the Surveyor Project staff.

This document, based on the slides presented and materials discussed and referred to at the Review, is published as an aide-memoire for participants in the Review. One other document, the Surveyor Project Status Report (Biweekly) as of 26 August 1963, contains material discussed in the Review, but is not reprinted here.

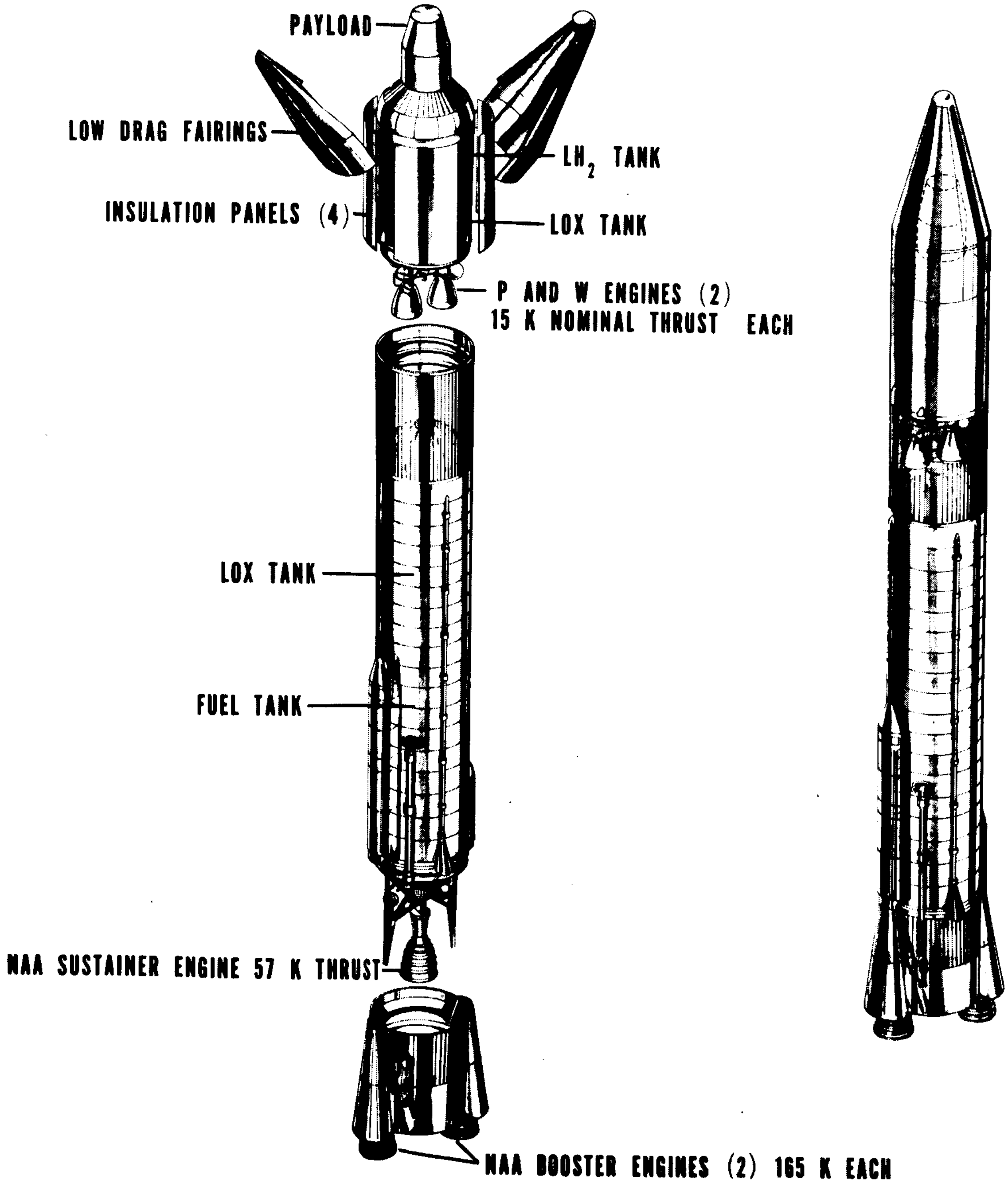
W E Giberson

W. E. Giberson
Surveyor Project Manager

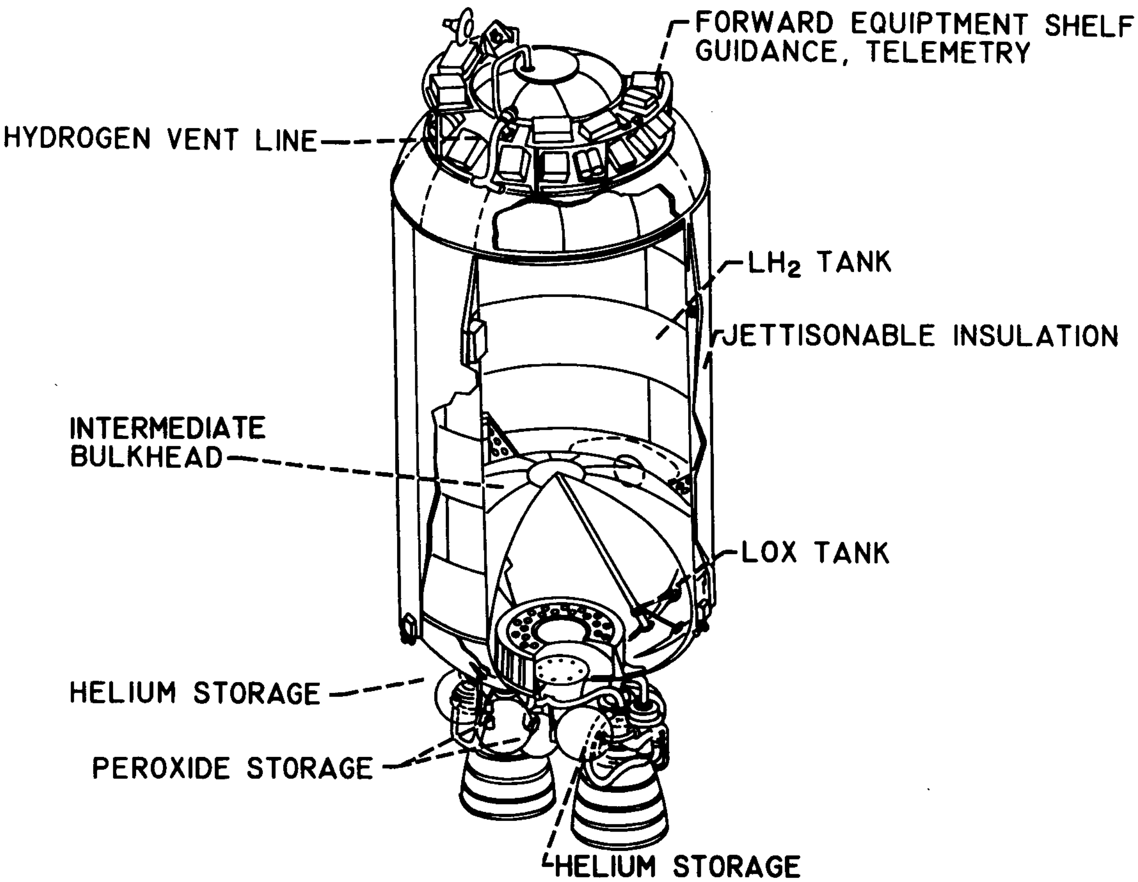
ATLAS-CENTAUR



ATLAS-CENTAUR VEHICLE



CENTAUR STAGE



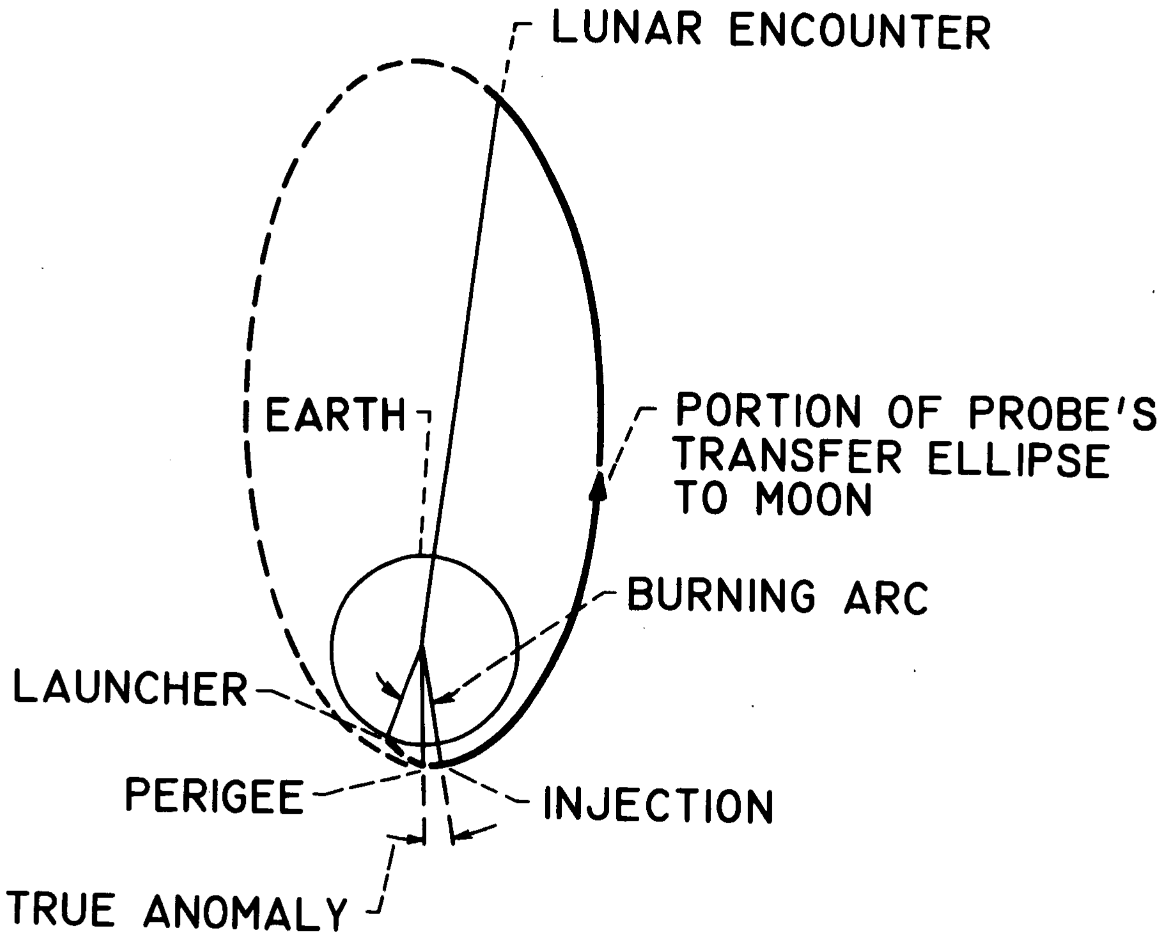
ATLAS/CENTAUR - R AND D VEHICLES

VEHICLE	MISSION	NUMBER BURNS	PAYLOAD	CONFIGURATION PARTICULARS
AC-2	ELLIPTICAL EARTH ORBIT	1	INSTRUMENTATION	NONJETTISONABLE INSULATION PANELS AND NOSE FAIRING
AC-3	ELLIPTICAL EARTH ORBIT	1	INSTRUMENTATION	JETTISONABLE INSULATION PANELS AND NOSE FAIRING
AC-4	CIRCULAR EARTH ORBIT	1	SIMULATED MASS	PROPELLANT COLLECTION EXPERIMENT; LOW THRUST COASTING
AC-5	DIRECT ASCENT - LUNAR	1	SURVEYOR DYNAMIC MODEL	165 K BOOSTER ENGINES; CENTAUR/PAYLOAD SEPARATION
AC-6	DIRECT ASCENT - LUNAR	1	SURVEYOR DYNAMIC MODEL	SMALL LOX TANK; IMPROVED PROGRAMMER; OPERATIONAL CONFIGURATION
AC-8	PARKING ORBIT - LUNAR	2	SIMULATED MASS	R AND D INSTRUMENTATION; LOW THRUST COASTING
AC-13	PARKING ORBIT - LUNAR	2	SIMULATED MASS	LOW THRUST COASTING

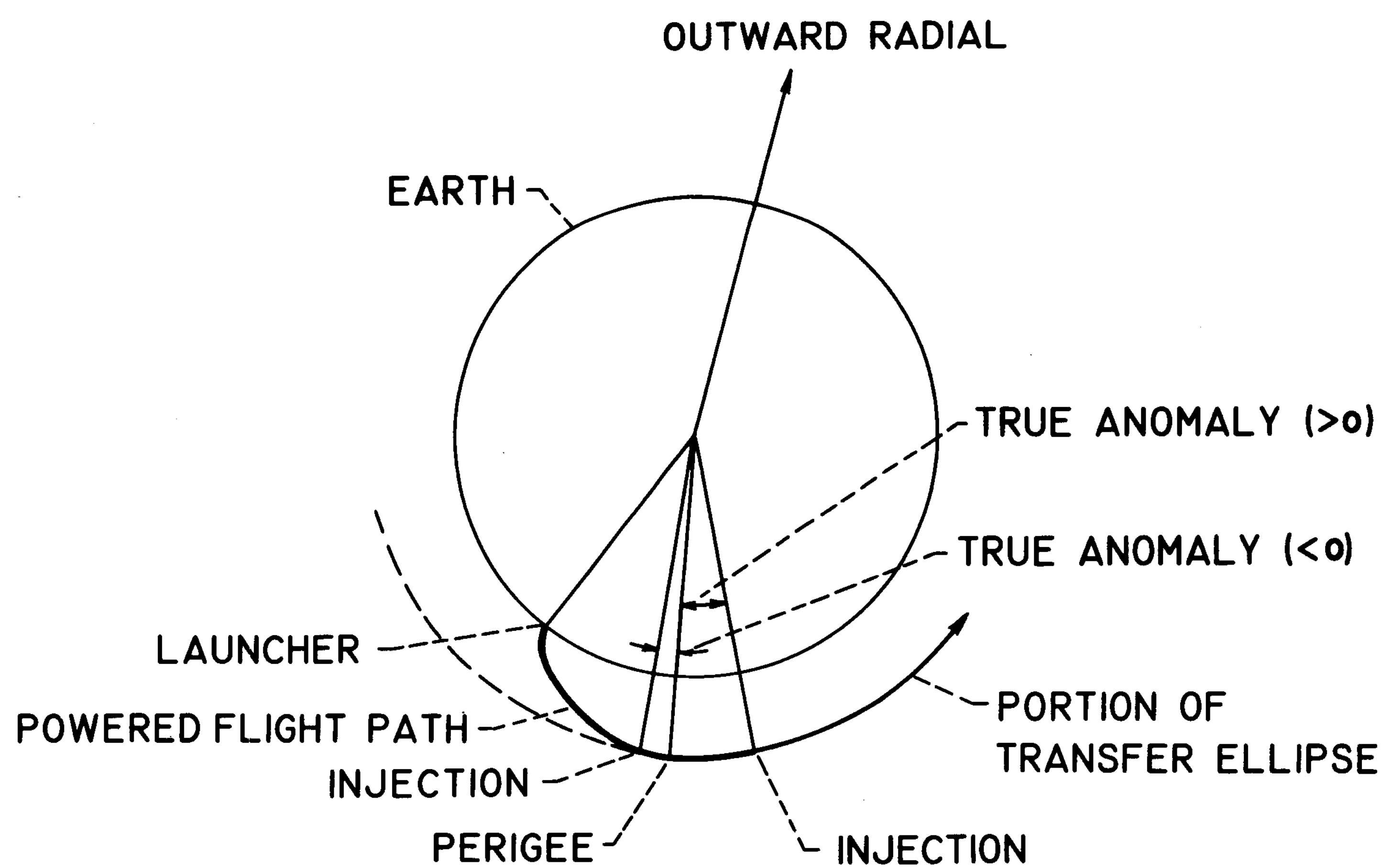
PROGRAM CHANGES UNDER LeRC MANAGEMENT

1. COMPREHENSIVE GROUND TEST PROGRAM
2. DIRECT ASCENT TRAJECTORY PROFILE
3. LINEAR SHAPED-CHARGE SEPARATION AND JETTISONING SYSTEMS
4. LIQUID HELIUM GROUND CHILL
5. SMALL LOX TANK ON CENTAUR
6. 165 K ENGINES ON ATLAS
7. IMPROVED PROGRAMMER
8. LOW THRUSTING MODE DURING COAST
9. NO VERNIER SOLO ON ATLAS

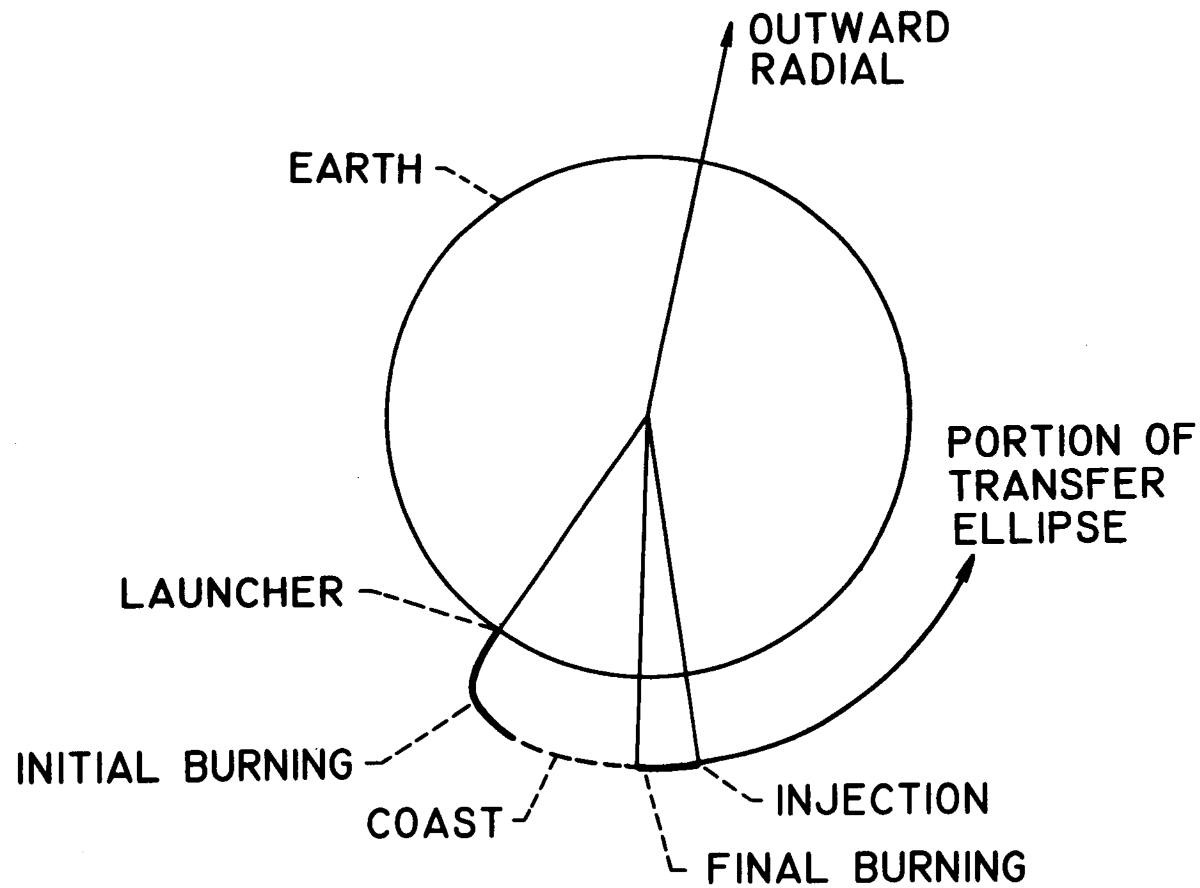
DIRECT - ASCENT LUNAR - TRAJECTORY GEOMETRY



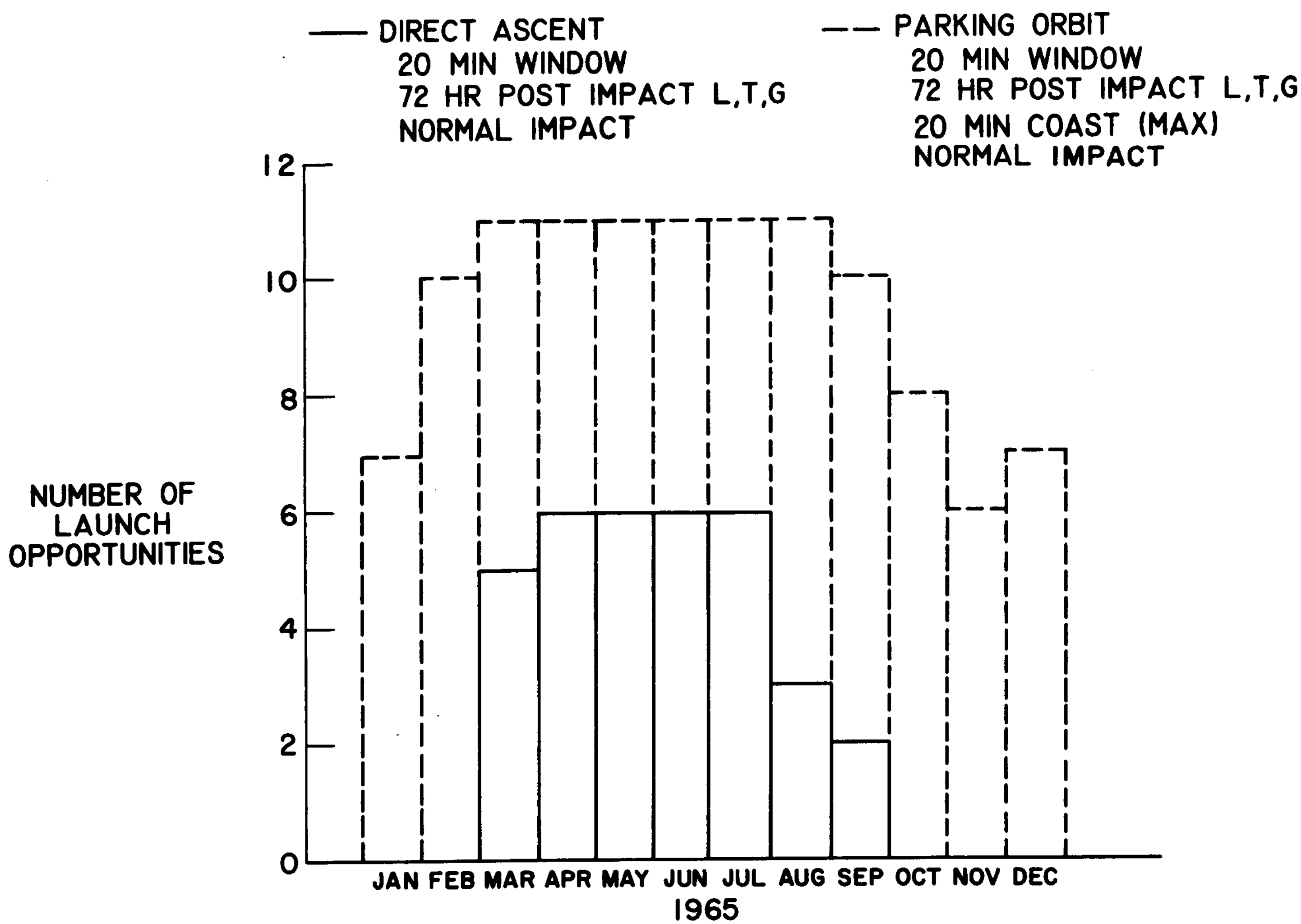
DIRECT-ASCENT TRAJECTORY



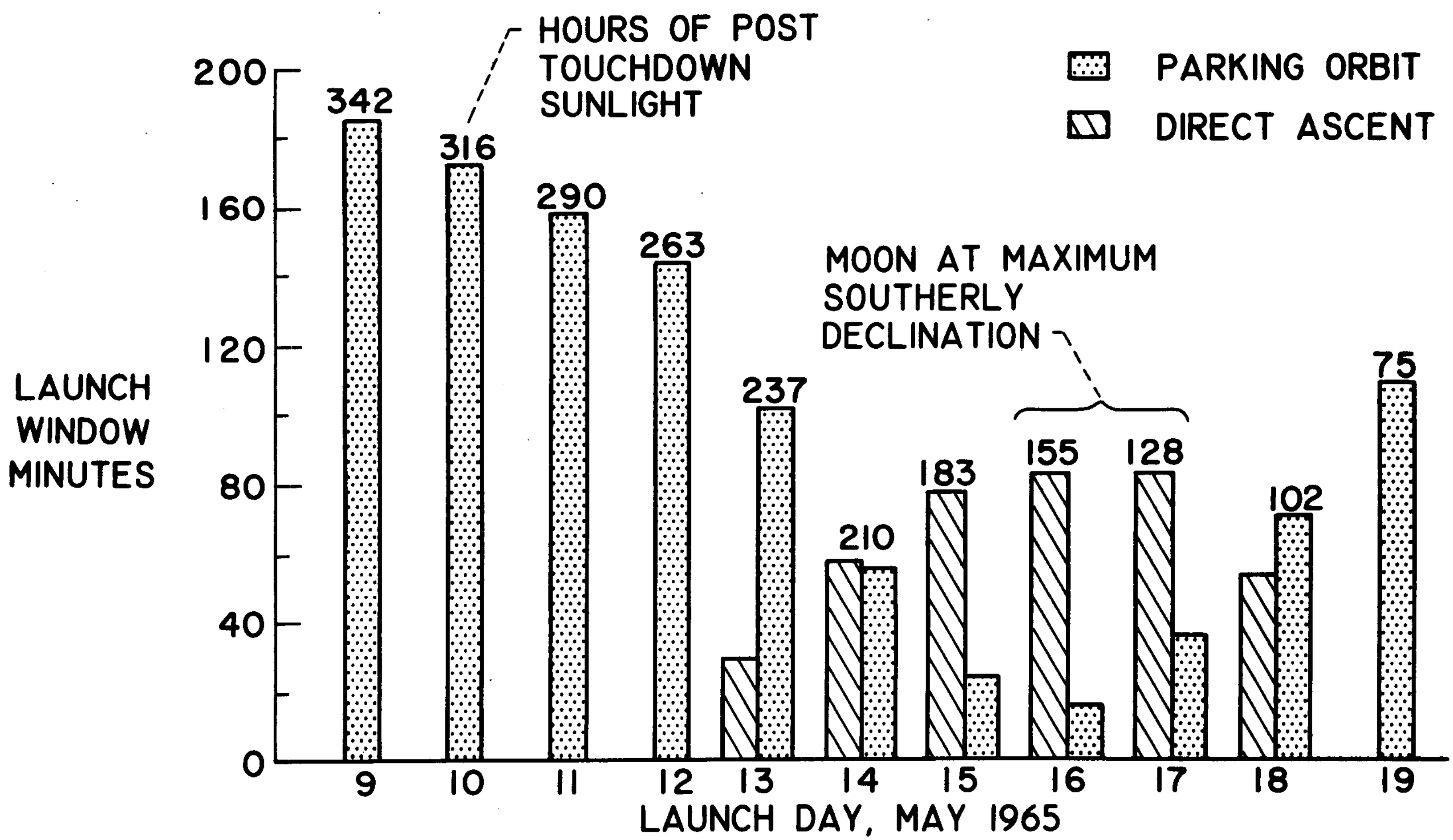
PARKING-ORBIT LUNAR-ASCENT-TRAJECTORY GEOMETRY



COMPARISON OF LAUNCH OPPORTUNITIES FOR 1965



LAUNCH WINDOWS



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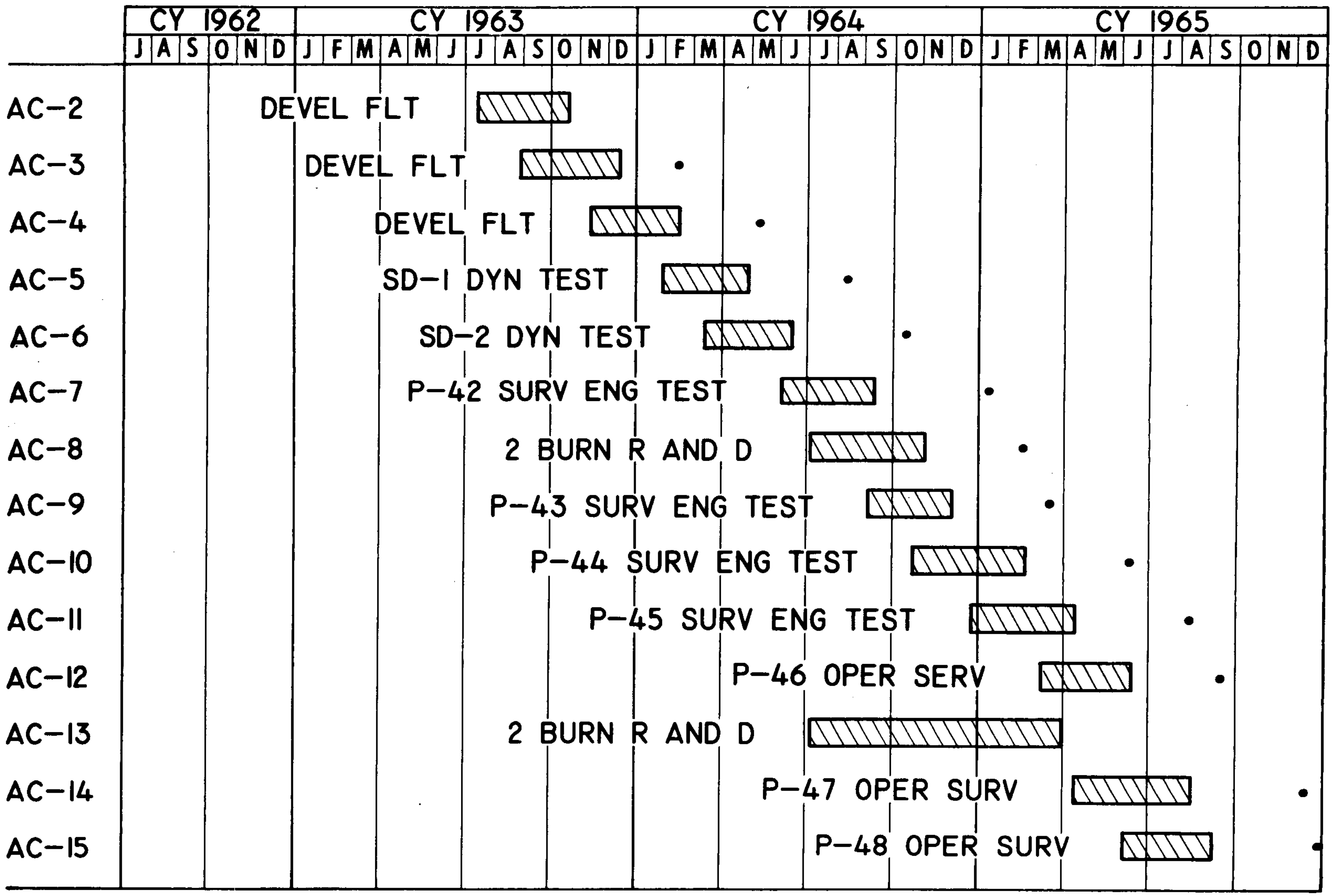

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PERFORMANCE PARAMETERS

		DIRECT ASCENT	PARKING ORBIT
1.	CENTAUR BURNS	1	2
2.	INJECTION TRUE ANOMALY	-6° TO $+14^\circ$	$+4^\circ$
3.	PARKING ORBIT ALTITUDE	N.A.	90 N.M.
4.	MAXIMUM COAST TIME	N.A.	20 MIN.
5.	TRANSFER ORBIT PERIGEE ALTITUDE	90 N.M.	N.A.
6.	POST IMPACT LIGHTING	$\geq$72 HRS.	$\geq$150 HRS.

PARAMETERS COMMON TO BOTH TYPES OF ASCENT

1.	LAUNCH AZIMUTH	90° TO 114°
2.	TRANSFER ORBIT ENERGY	-1.70 (KM/SEC)^2 TO -0.85 (KM/SEC)^2
3.	IMPACT OBLIQUITY	$\pm 25^\circ$ TO VERTICAL
4.	MINIMUM LAUNCH WINDOW	20 MIN.
5.	FLIGHT PERFORMANCE RESERVE	3σ
6.	ATLAS BOOSTER ENGINE THRUST	330,000 LBS.
7.	ATLAS BOOSTER ENGINE I_{SP}	253 SEC.
8.	SUSTAINER ENGINE THRUST	57,000 LBS.
9.	SUSTAINER ENGINE I_{SP}	215 SEC.
10.	CENTAUR MAIN ENGINE THRUST	30,000 LBS.
11.	CENTAUR MAIN ENGINE I_{SP}	430 SEC.

PERFORMANCE

STAGE	GROSS WEIGHT, LB	EXPENDABLES, LB	ΔV, FT/SEC
ATLAS	263,243	247,513	11,625
CENTAUR (DIRECT ASCENT)	36,486	29,880	23,225
CENTAUR (PARKING ORBIT)	36,160	29,316	23,175

	PAYLOAD, LB
DIRECT ASCENT	2299
PARKING ORBIT	2229

PERFORMANCE IMPROVEMENTS UNDER STUDY

		ΔPAYLOAD, LB
1.	INCREASED AREA RATIO NOZZLES	50-100
2.	USE OF TITAN II BOOSTER	600
3.	FLUORINE ADDITIVE FOR LOX IN ATLAS	300
4.	USE OF RJ FUEL IN LIEU OF RP FUEL FOR ATLAS	20
5.	HOT GASEOUS HYDROGEN TANK PRESSURIZATION (LH_2 TANK)	50
6.	CHEM.-MILLED TANK	60
	Redesign front end of Centaur	≈100

$50M incl. flight test

CENTAUR-SURVEYOR INTERFACE ACTIVITIES

I. SPECIFICATION DEFINITION

II. DESIGN REVIEW OF INTERFACE HARDWARE

(a) SURVEYOR DESTRUCTION UNIT

(b) ELECT DISCONNECT

(c) SEPARATION LATCHES

(d) SURVEYOR TEMPERATURE CONTROL ON PAD

(e) TELEMETRY REQUIRED BY SURVEYOR

III. JOINT TEST PLANNING

(a) MATCH MATE -

(b) AIR CONDITIONING

(c) SEPARATION

(d) COMBINED SYSTEM TEST

(e) JOINT OPERATIONAL COMPATIBILITY TEST

AC-5 through AC-15	ATLAS/CENTAUR - TYPICAL LEADTIMES AND FUNDING REQUIREMENTS								
	MONTHS LEADTIME								ITEM COSTS (MILLIONS)
ITEM DESCRIPTION	24 23 22	21 20 19	18 17 16	15 14 13	12 11 10	9 8 7	6 5 4	3 2 1	
GO AHEAD									
PROCUREMENT									
NOSE FAIRING					.248				.248
ADAPTER					.054				.054
INERTIAL GUIDANCE SYSTEM		.849							.849
LOX SUMP				.003					.003
AUTOPILOT	.124								.124
INSULATION PANELS					.110				.110
TELEMETRY			.075						.075
PROPELLANT PRESSURIZATION			.100						.100
PROPELLANT UTILIZATION			.006						.006
ATTITUDE CONTROLS			.073						.073
ENGINES	.415		.415						.830
FABRICATION & ASSEMBLY		.100	.200	.700	.454	.700			2.154
			Structural Fab.		Mech. & Elec.		C.O.		
COMBINED SYSTEMS TESTING							.300		.300
PAYLOAD INTEGRATION	.050	.050	.100	.200	.300	.200	.105		1.005
SPARES & PROPELLANTS	.050	.100	.050	.100	.109				.409
AMR OPERATIONS								1.920	1.920
SUB TOTAL	.639	1.099	1.019	1.003	1.275	.900	.405	1.920	8.260
ATLAS BOOSTER PROCUREMENT		1.016		.507	.417	.255		.020	2.215
TOTAL UNIT COST									10.475
TOTAL QUARTERLY FUNDING REQUIREMENT	.639	2.115	1.019	1.510	1.692	1.155	.405	1.940	10.475

AC-5 & ON

ATLAS BOOSTER - TYPICAL LEADTIMES AND FUNDING REQUIREMENTS

ITEM DESCRIPTION	MONTHS LEADTIME 24 23 22	21 20 19	18 17 16	15 14 13	12 11 10	9 8 7	6 5 4	3 2 1	ITEM COSTS (MILLIONS)
GO AHEAD									
PROCUREMENT									
AIRFRAME		.700		.300	.250	.209			1.459
PROPULSION		.250		.150	.100				.500
TECHNICAL SUPPORT		.040		.010	.010	.005			.065
PRODUCTION GASES		.006		.002	.002	.002			.012
INSTRUMENTATION		.020		.010	.005	.004			.039
MODIFICATIONS: ECP IMPACTS					.050				.050
165K ENGINES				.035		.035			.070
TRANSPORTATION								.020	.020
TOTAL QUARTERLY FUNDING REQUIREMENT		1.016		.507	.417	.255		.020	2.215

DESIGN STATUS BRIEF

August 13, 1963

1. Receiver and Exciter

Prototype modules are being received from Motorola and are being checked out, modified where necessary, and released for production. 14 modules out of 65 have been frozen and released for production. It is expected that all modules will be released by January 1, 1964. The mechanical package is being finalized, and a wooden mockup of the modules is being built to provide interference and cable length design data.

The feasibility model of the sum channel is being tested at the present time, and within a month the telemetry channel will be tested. Preliminary results indicate that the required characteristics have been demonstrated.

The block diagram for the test receiver/transmitter has been completed, and detailed design at Motorola will begin within a month.

2. Transmitter

The design is essentially complete. Only minor modifications of waveguide switches are being made. The design being used for the Canberra and Madrid stations is an evolution of the transmitters now in use in the DSIF.

3. Ranging

The paper design has been completed for the GSDS ranging system. (The feasibility model was demonstrated approximately one year ago.) All subassemblies have been built, and 80% have been checked out. The complete unit will be tested in October, 1963.

4. Tracking Data Handling

The Tracking Data Handling has been GSDS for a number of years. One major addition has been the time and frequency reference assembly. This contains precision oscillators and frequency synchronizers. Design work on this assembly is about 50% complete.

5. Station Instrumentation

The Digital Instrumentation assembly design is approximately 95% complete. Minor interface equipment for display and control purposes is still in the design phase. The prototype Digital Instrumentation assembly was placed in operation in early 1963.

6. Antenna Mechanical

The status on the various antenna design modification is as follows:

a. Electronics Cage

Essentially complete. A full size mockup is being built to facilitate mechanical placement of antenna mounted equipment and cable and wave-guide routing.

b. Counterweight Cage

Design is about 85% complete. Approximately 10% spare volume for additional weights is being allowed.

c. Environmental Equipment

Design is complete and parts are being ordered. The design utilizes standard commercial parts.

d. Antenna Modified Design

Design work on modifications to permit additional hour angle coverage will be initiated by Blaw-Knox on September 1, 1963, the scheduled date for contract execution.

e. Low Speed Antenna Drive

The paper design including stability criteria is complete and will be submitted for design review in September, 1963.

7. Antenna Microwave

The basic mechanical layout is almost complete. A one-quarter scale mockup of both the Cassegrain cone and electronics cage are being used to assist in mechanical design areas.

The basic microwave switch to be used throughout the subsystem will be evaluated in September, 1963. The basic prototype feed is presently available, but an improved feed is being worked on under subcontract to Hughes Aircraft. It will embody higher efficiency and lower noise than the present feed. It is about 33% complete. A decision will be made at a later date as to which feed will be used as GSDS. The modal design of the microwave switching circuitry is being worked on and the design is about 40% complete.

The basic TWM structure for the maser system has been designed and is under order from Airborne Instrument Laboratory (AIL), and the magnet design will be furnished by AIL. The basic CCR problems have been solved. Initial tests of the maser assembly with the receiver front end indicated a spurious frequency generation problem between the maser pump klystron and the receiver local oscillator. This has been subsequently eliminated with a filter. The maser system will be integrated into the microwave assembly during the latter part of 1963.

Several changes may be incorporated in the microwave subsystem block diagram. For the most part, these involve changes in modes and additional facility for testing. These changes will undergo a design review in September, 1963.

8. Mission Monitor Console

Design work in this area is about 30% complete.

9. Acquisition Aid

The basic acquisition aid feed design has been completed, and a prototype is being built. The basic design areas to be proven include the microwave switching and antenna control transfer from the acquisition feed to the high gain feed. Prototype tests will be conducted at Goldstone in November, 1963 providing a receiver can be made available.

10. L to S Conversion

The L to S conversion equipment is very similar to the S-band equipment. Drawer type construction is being used. All preliminary layouts have been completed. The design is approximately 95% complete, but the prototype must be built. It has been decided to remove the frequency synthesizer capability from the L to S system.

11. Telemetry and Command Data Handling

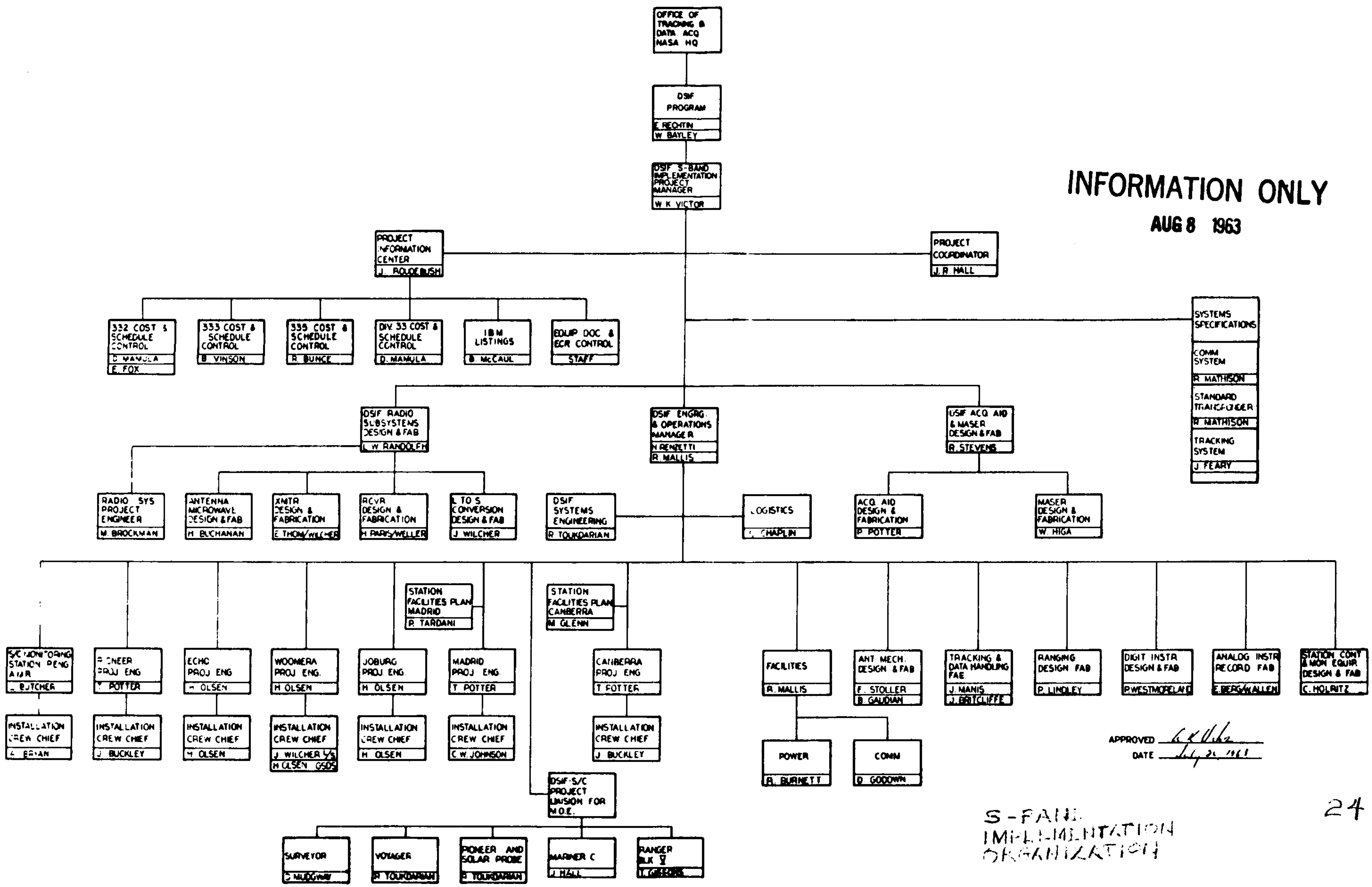
This area is mainly a spacecraft systems responsibility. Surveyor and MA-C interface tests will be conducted in early 1964.

12. Recording

FR-700 capability is approximately 95% complete with test, monitor, and down-converter yet to be finished. FR-1400 and FR-100 design is complete.

INFORMATION ONLY

AUG 8 1963

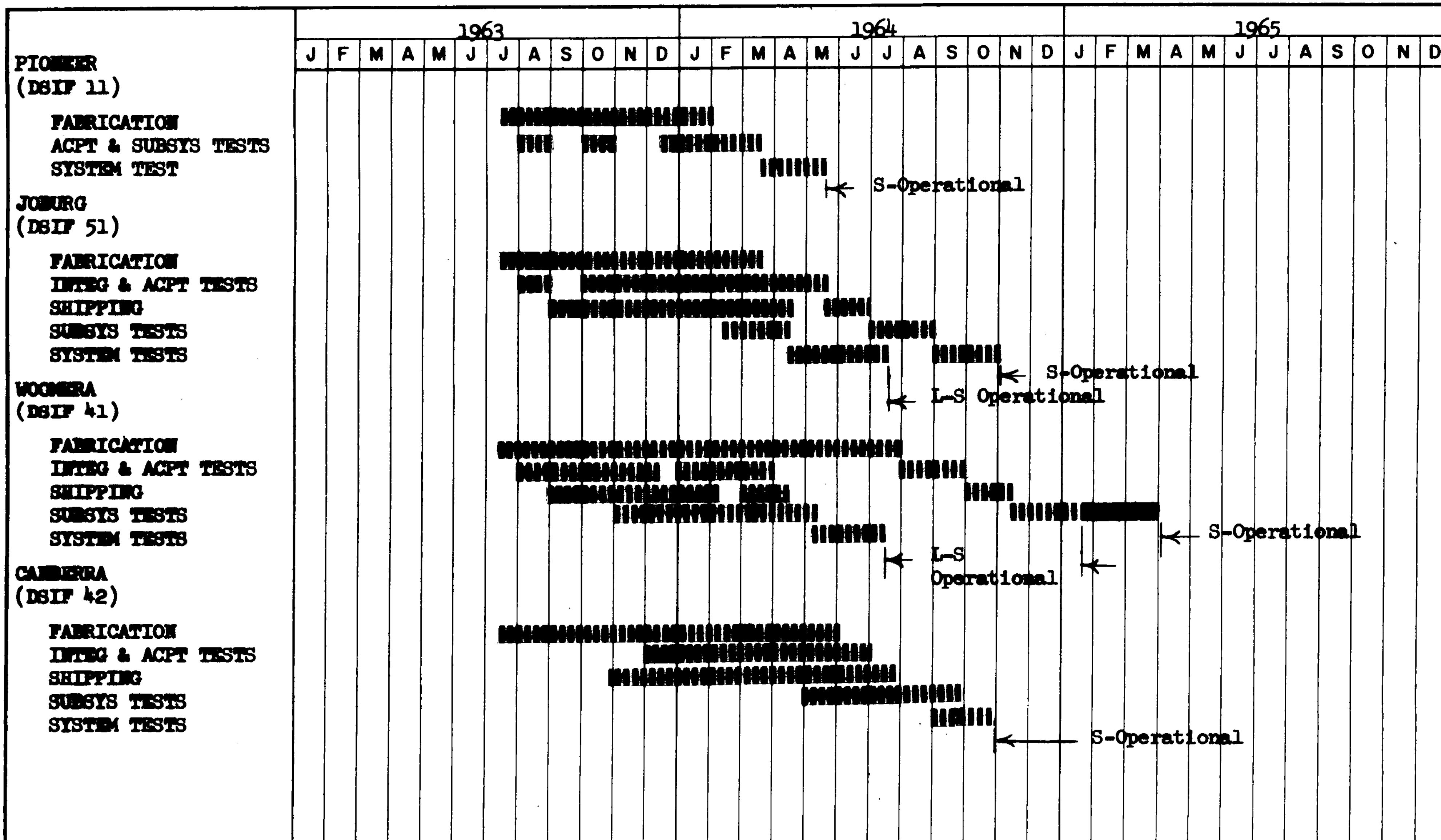


APPROVED [signature]

DATE July 26, 1963

S-BAND IMPLEMENTATION ORGANIZATION

DSIF "S" BAND IMPLEMENTATION SCHEDULE



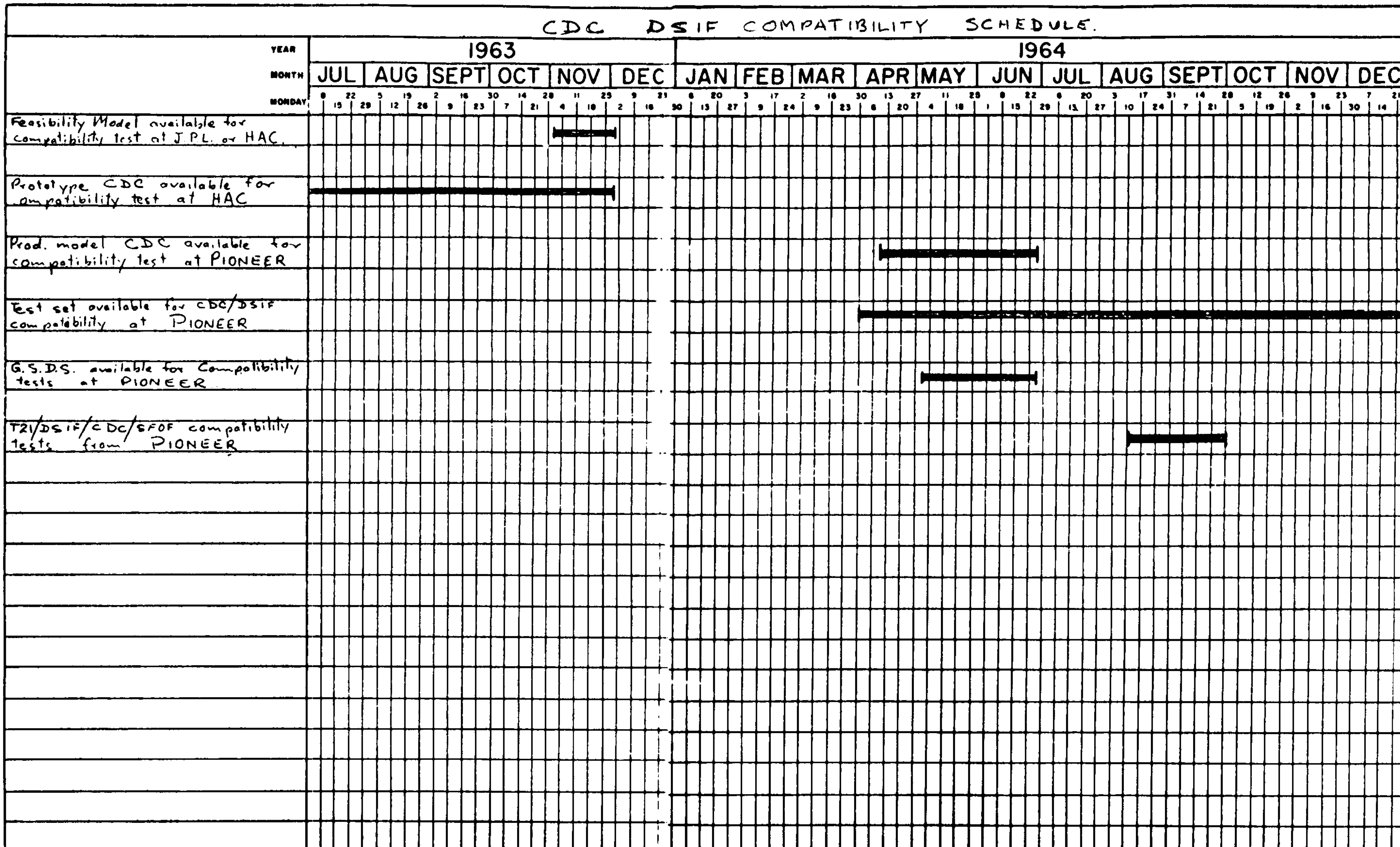


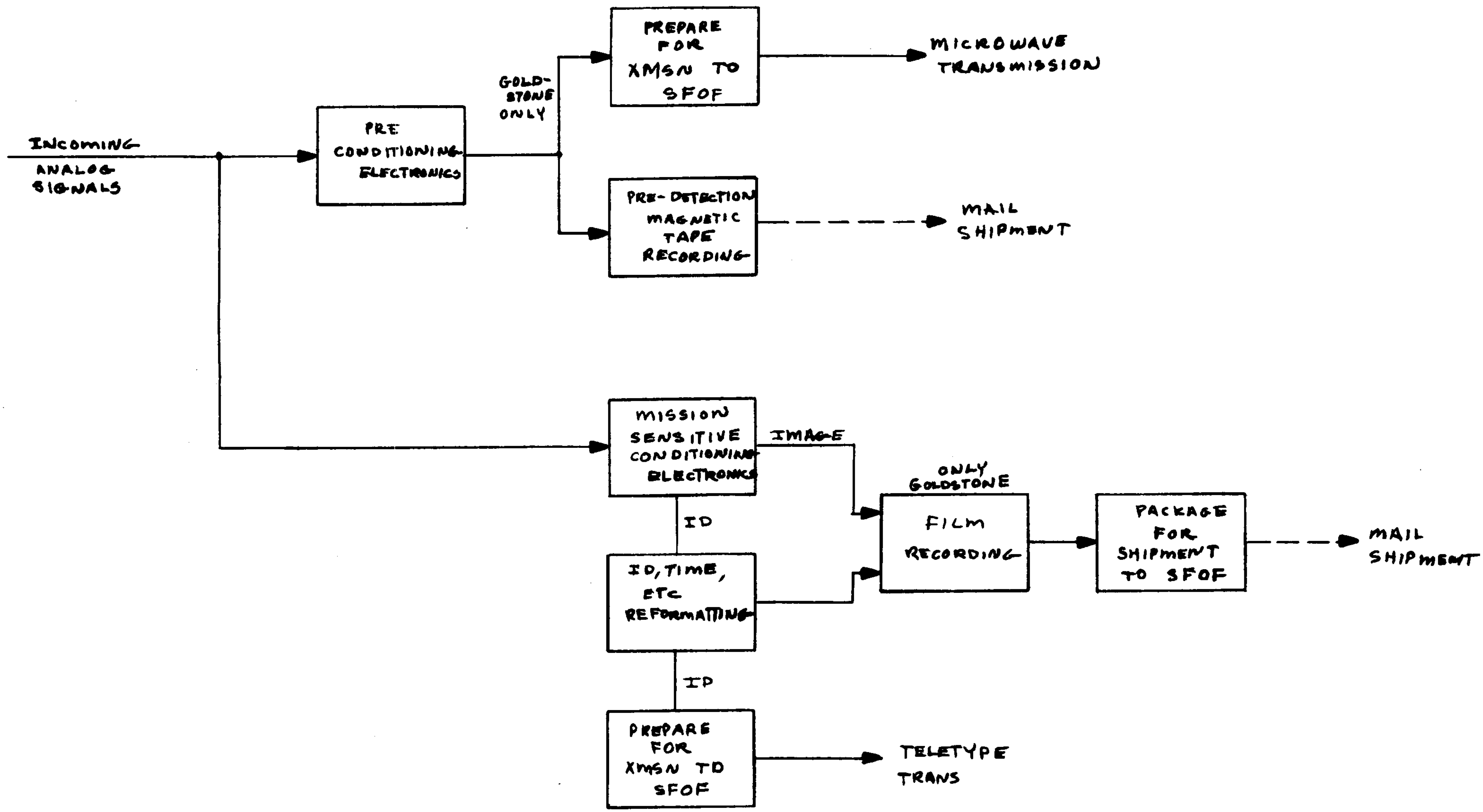
FIG. 1

PREPARED BY D.J. MUDGWAY

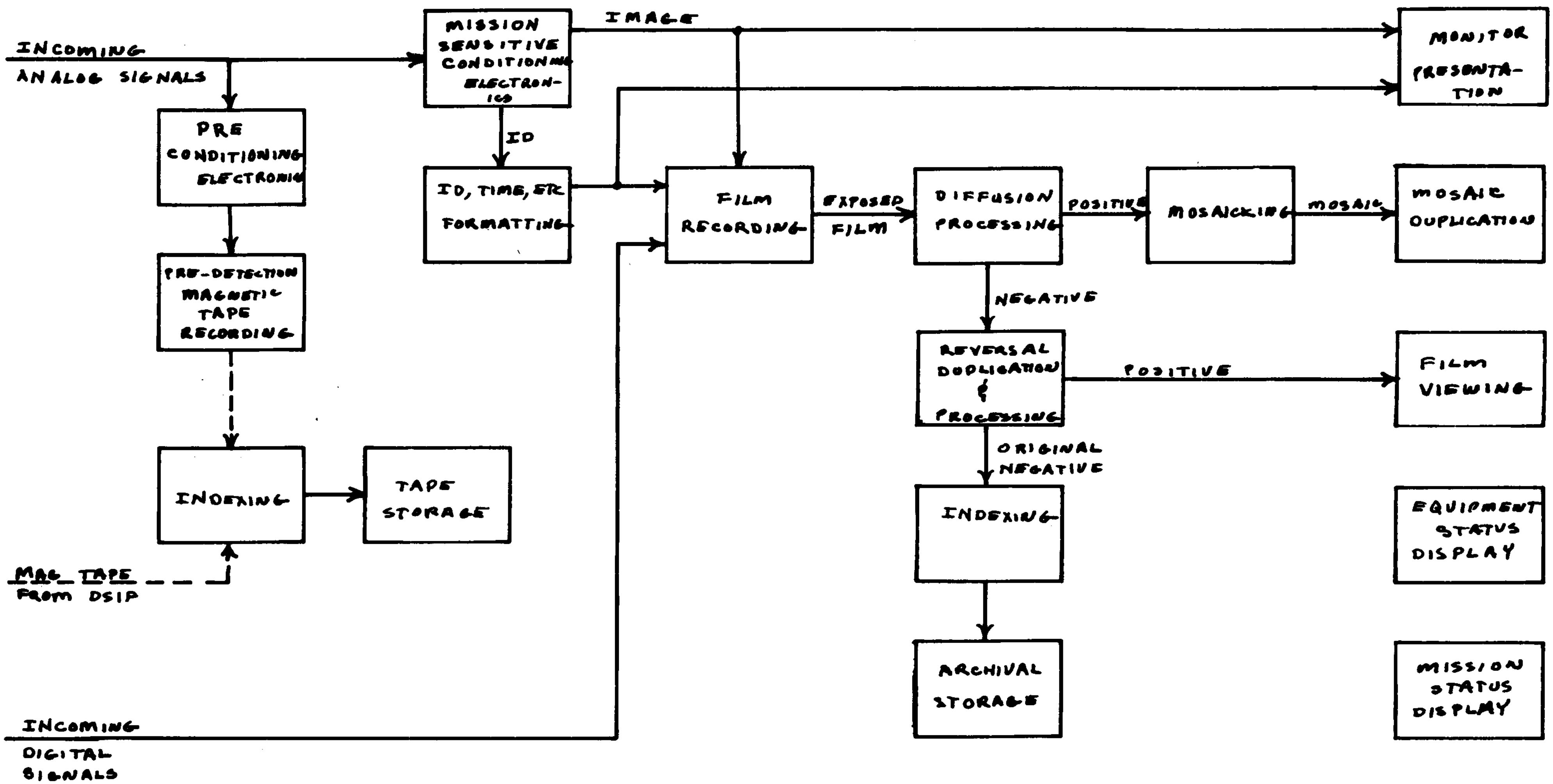
DATE 13/8/63.

APPROVED

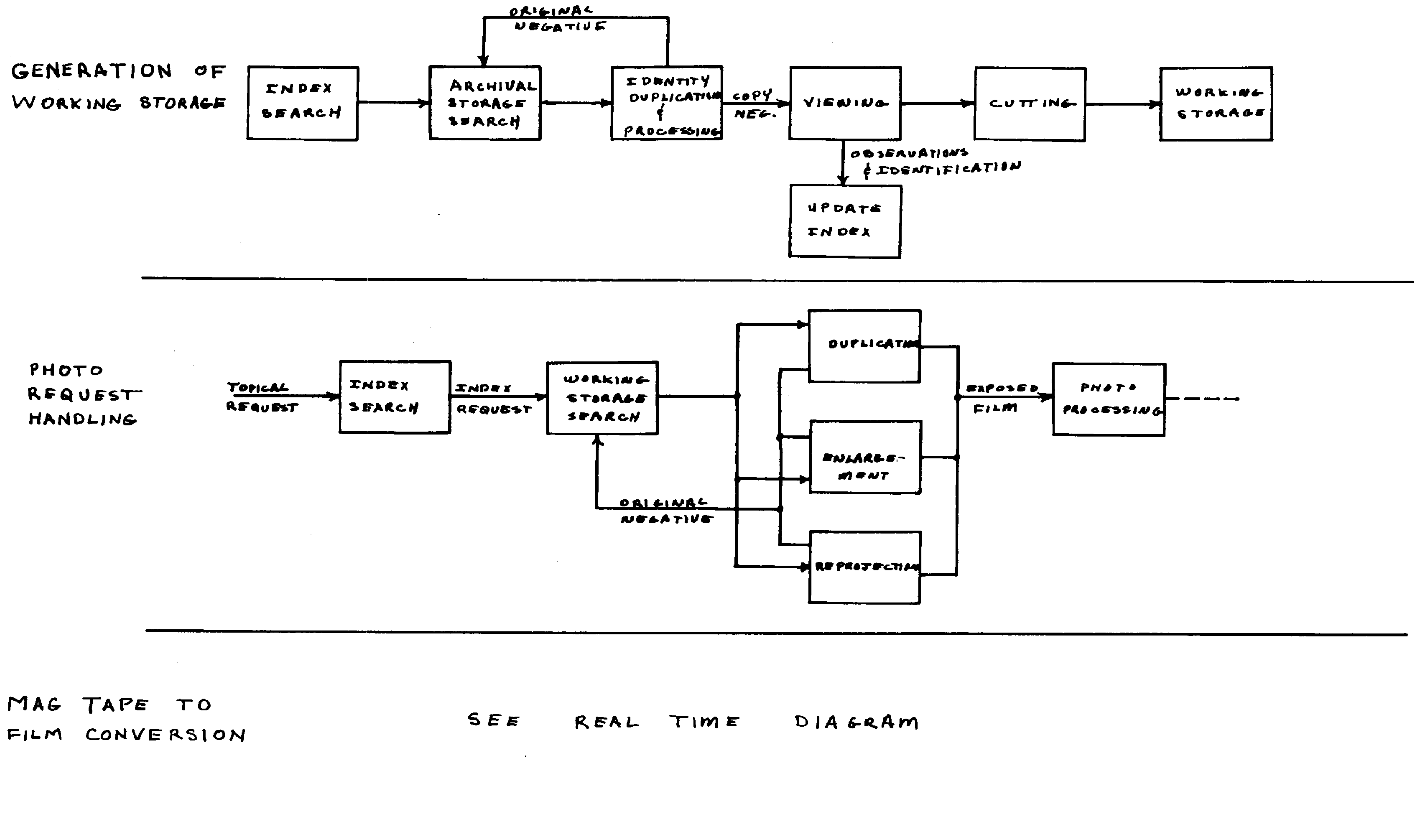
DATE



DSIF DATA HANDLING

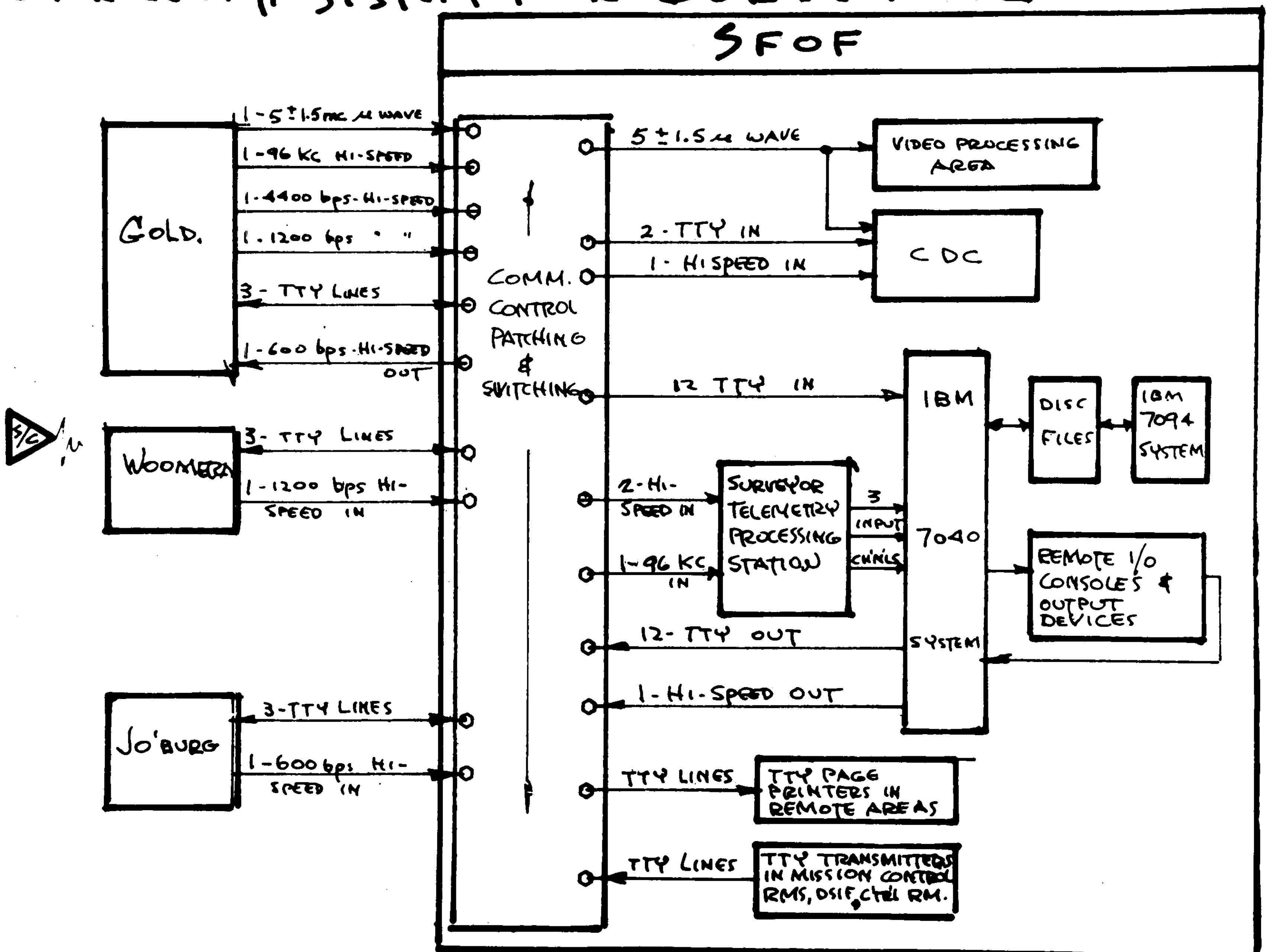


SFOF REAL TIME HANDLING

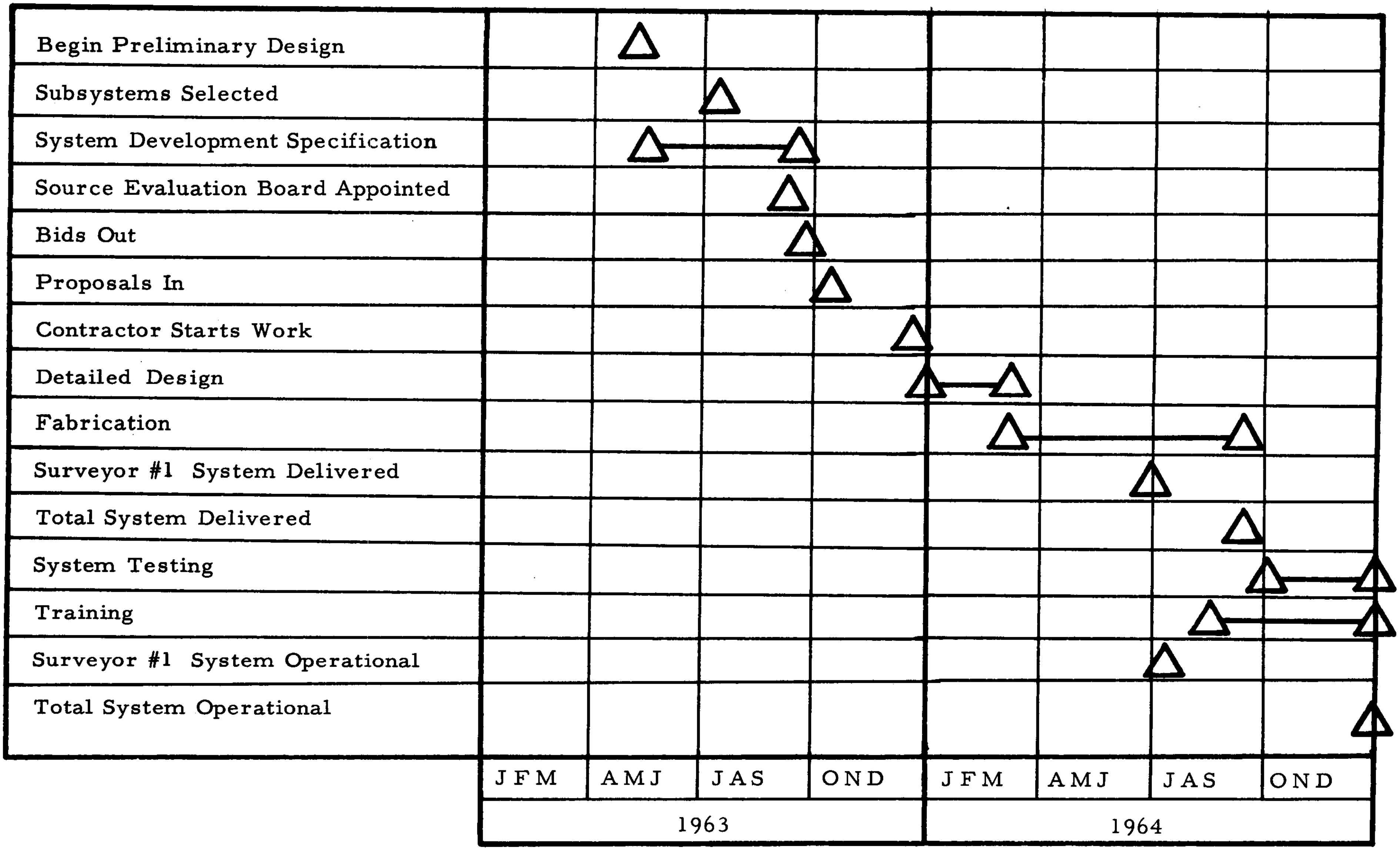


SFOF NON-REAL-TIME HANDLING

OVERALL DATA SYSTEM FOR SURVEYOR



SPACECRAFT TELEVISION GROUND DATA HANDLING SYSTEM
OVERALL SUMMARY SCHEDULE



Surveyor Science Review

August 27, 1963

A. Overall Science Program

1. Payload Redirection
2. Schedule Constraints
3. Resource Constraints
4. Non Payload Instrument Status
5. Mission Operations
6. Experimenter Meeting
7. Experimenter Agreement

B. System Activities

8. Instrument Integration
9. Data Handling

C. Status of Experiments

10. Alpha Scattering
11. Seismometer
12. Surface Sampler
13. T.V.
14. Micrometeorite Detector
15. Touchdown Dynamics
16. Field Trip Film

SURVEYOR EXPERIMENTS AND EXPERIMENTERS

EXPERIMENT	DESCRIPTION	wt, lb	*INVESTIGATOR;* CO-EXPERIMENTERS
TELEVISION	2 HORIZONTAL CAMERAS	37.1	*E. M. SHOEMAKER;* G. P. KUIPER, E. WHITAKER
MICROMETEORITE EJECTA	———	13.3	*W. M. ALEXANDER;* O. E. BERG, L. SECRETAN, C.W. Mc CRACKEN
SEISMOMETER	(SINGLE - AXIS)	15.0	*G. H. SUTTON;* M. EWING, F. PRESS
ALPHA SCATTERING	INSTRUMENT DEPLOYED TO LUNAR SURFACE	11.4	*A. TURKEVICH;* J. PATTERSON, E. FRANZGROTE
SURFACE SAMPLER	(USED AS SOIL PROPERTIES MEASURING DEVICE)	10.6	*R. F. SCOTT;* R. M. HAYTHORNTHWAITE R. A. LISTON
TOUCHDOWN DYNAMICS		4.2	*S. A. BATTERSON*

PAYLOAD INSTRUMENT DELIVERY SCHEDULE

Payload Evaluation Models	?
Prototype Models for T-21A	1 March 1964
Flight Models:	
1 Set	24 July 1964
1 Set	25 August 1964
1 Set	25 September 1964
1 Set	9 October 1964

SURVEYOR BLOCK I

FY 64 BUDGET

ACTIVITY	Average Personnel	In-House	Procurement	Total
Project Management	5.0	103	54	157
Instruments				
Seismometer	3.5	53	201	254
Soil Mechanics	5.2	78	699	777
X-Ray Diffractometer	7.3	118	493	611
Alpha Scattering	7.4	110	451	561
TV	11.6	191	768	959
Surface Sampler & Processor	4.1	58	157	215
Surface Density	.6	11	22	33
Science System Activities				
Science Instrument Support	1.0	17	6	23
System Integration	2.0	37	30	67
Planning and Scheduling Support	1.0	19	78	97
Reliability and Quality Assurance	1.0	17	17	34
Operational Support Equipment	1.2	24	14	38
Science Data Handling	2.5	40	122	162
TOTALS	53.4	876	3112	3988

7/18/63

SURVEYOR
SPACE SCIENCE DIVISION 32
CONTRACT STATUS

DESCRIPTION	CONTRACTOR	VALUE-FY 61	VALUE-FY 62	VALUE-FY 63
Lunar Compositional Analysis Study Program	Philips Electronic Instru.	$131,244.00	$ 61,246.42	
Lunar Drill & Physical Parameters Study Program	Texaco, Inc.	247,130.00	22,362.00	
Lunar Drill Study Program	Armour Research Foundation	53,674.00		
Lunar Compositional Analysis Study Program	The Bendix Corporation	96,637.00		
Lunar Compositional Analysis Study Program	Beckman Instruments	55,115.00	11,192.00	
Lunar Compositional Analysis Study Program	Kaman Nuclear	29,139.00		
Lunar Compositional Analysis & Physical Parameters Study	Dresser Industries, Inc. (Wells Surveys, Inc.)	50,495.00		
Study Program for Gas Chromatography	Aerojet-General	163,220.00	15,519.00	
Lunar X-Ray Diffractometer Study Program	Philips Electronic Instruments	101,161.91		
Rocket Radar Design	The Bendix Corporation	110,000.00	55,690.00	
Dynamic Reed Capacitor Modulator	Applied Physics Corporation	23,829.00	21,061.08	
Surveyor Lander Pulse Height Analyzer	University of Chicago		68,970.00	
Surveyor Orbiter Pulse Height Analyzer	Loral Electronics		90,000.00	89,015.00
Surveyor Orbiter Gamma Ray Detector	Packard Instrument Co.		15,000.00	

SURVEYOR
SPACE SCIENCE DIVISION 32
CONTRACT STATUS

DESCRIPTION	CONTRACTOR	VALUE-FY 61	VALUE-FY 62	VALUE-FY 63
Laboratory Model - Lunar Seismometer System	Columbia University		$131,480.00	$ 30,000.00
Surveyor Lander Surface & Subsurface Geophysical Instruments	Texaco Experiment Inc.		761,193.00	79,226.00
Surveyor Lander Magnetometer	Marshall Laboratories		189,076.00	
Surveyor Lander Seismograph	Columbia University		261,412.32	
Surveyor Lander Geiger Counter Assembly	Electro-Optical Systems, Inc.		37,342.00	6,091.00
Lunar Breadboard Petrographic Microscope	Armour Research Foundation		48,790.00	1,200.00

SOIL MECHANICS INSTRUMENT

Funding: FY 62 $302,034 FY 63 $574,018

Status of Hardware

Configuration	Status
Mock-up Model	Delivered
Thermal Model	Delivered
Breadboard Model	Delivered
Prototype (P-1)	Delivered
Development (P-2d)	Disassembled
Prototype (P-2)	Undeliverable

Aug. 23, 1963

X-RAY SPECTROGRAPH

Funding FY 62 $550,380 FY 63 $230,336

Status of Hardware

Configuration	Status
Mock-up Model	Delivered
Thermal Model	Delivered
Prototype (Model A)	At PEI
Prototype (P-1)	Delivered
Prototype (P-2)	Destroyed
Prototype (P-3d)	
Prototype (P-3)	

Aug. 23, 1963

X-RAY DIFFRACTOMETER

Funding: FY 62 $357,294 FY 63 $431,409

Status of Hardware

Configuration	Status
Mock-up Model	Delivered
Thermal (T-1)	Delivered
Thermal (T-2)	Delivered
Prototype (Model A)	Delivered
Prototype (P-1)	Delivered
Prototype (P-2)	Delivered
Prototype (P-3)	Delivered
Development (P-3d)	Disassembled
Prototype (P-4)	Due 9-30-63
Prototype (P-5)	Due 10-15-63

Aug. 23, 1963

GAS CHROMATOGRAPH

Funding: FY 62 $562,716 FY 63 $119,242

Status of Hardware

Configuration	Status
Mock-up Model	Delivered
Thermal Model	Delivered
Prototype (P-1)	Delivered
Development (P-2d)	Delivered
Prototype (P-2)	Delivered

Aug. 23, 1963

4

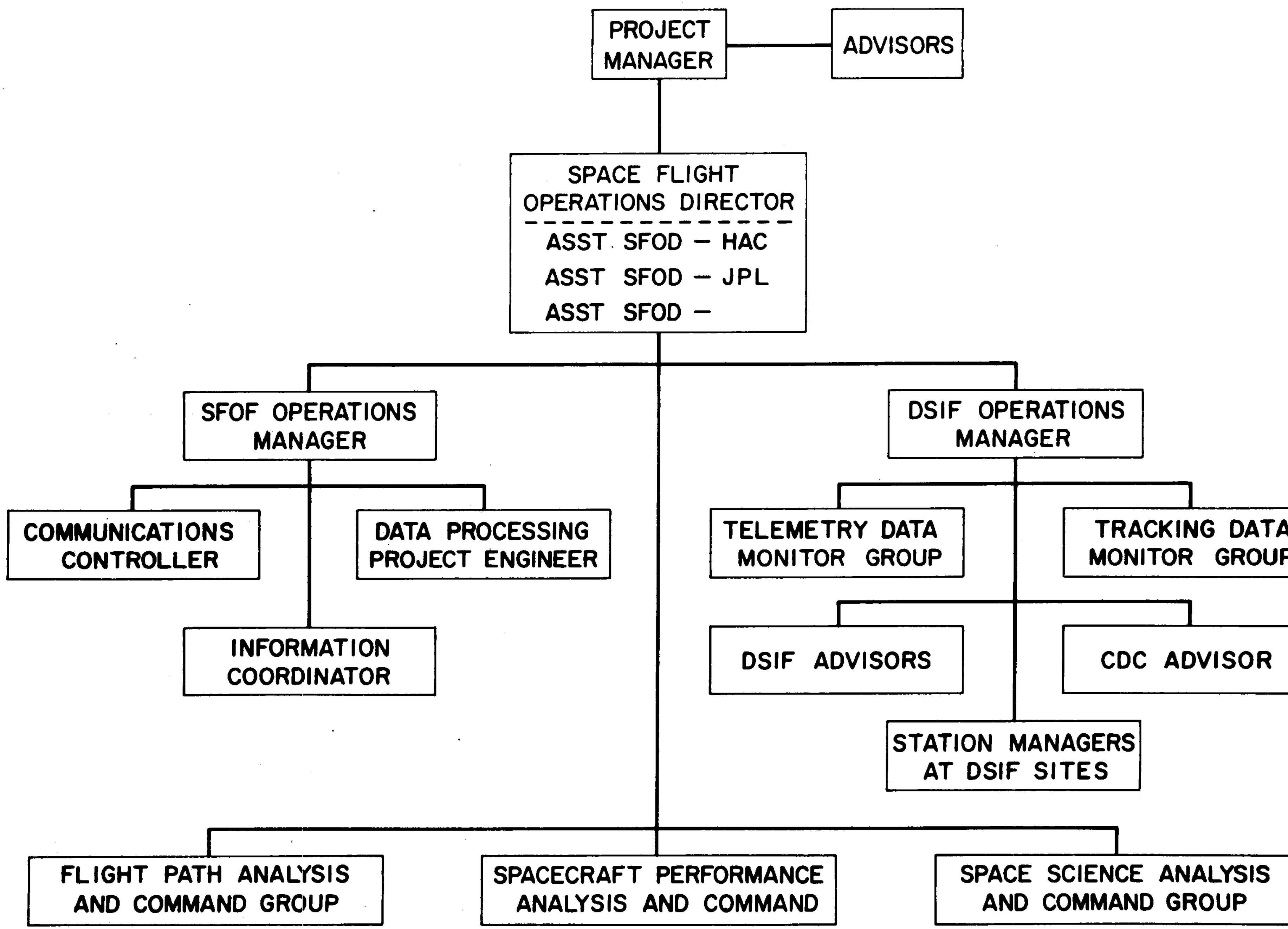
PHYSICAL PARAMETER INSTRUMENTS

Funding:	FY 62	$761,193	FY 63	$79,226
			FY 64	($250,000)?

Status of Hardware

Configuration	Status
Mock-up (Surface)	Delivered
Mock-up (Subsurface)	Delivered
Thermal (Surface)	Delivered
Thermal (Subsurface)	Delivered
Prototype (P-1 Surface)	Delivered
Prototype (P-1 Subsurface)	Delivered
Development (P-2d Surface)	Not Delivered
Development (P-2d Subsurface)	Not Delivered
Prototype (P-2 Surface)	Not Delivered
Prototype (P-2 Subsurface)	Not Delivered

Aug. 23, 1963


PROJECT MANAGER
ADVISORS
SPACE FLIGHT OPERATIONS DIRECTOR
ASST SFOD — HAC
ASST SFOD — JPL
ASST SFOD —
SFOF OPERATIONS MANAGER
COMMUNICATIONS CONTROLLER
DATA PROCESSING PROJECT ENGINEER
INFORMATION COORDINATOR
DSIF OPERATIONS MANAGER
TELEMETRY DATA MONITOR GROUP
TRACKING DATA MONITOR GROUP
DSIF ADVISORS
CDC ADVISOR
STATION MANAGERS AT DSIF SITES
FLIGHT PATH ANALYSIS AND COMMAND GROUP
SPACECRAFT PERFORMANCE ANALYSIS AND COMMAND
SPACE SCIENCE ANALYSIS AND COMMAND GROUP

AGENDA

SURVEYOR EXPERIMENTER MEETING

August 29, 30, 1963

August 29	Welcome Project review Space Flight Operations Facility Space Flight Operations Complex Space Science Analysis and Command Function Joint Principal Investigator / Surveyor Project Office Agreement
August 30	Science Programs Data Processing and Display Requirements Experimenter/ Cognizant Scientist/ Cognizant Engineer Discussions

PRINCIPAL INVESTIGATOR/SURVEYOR PROJECT OFFICE

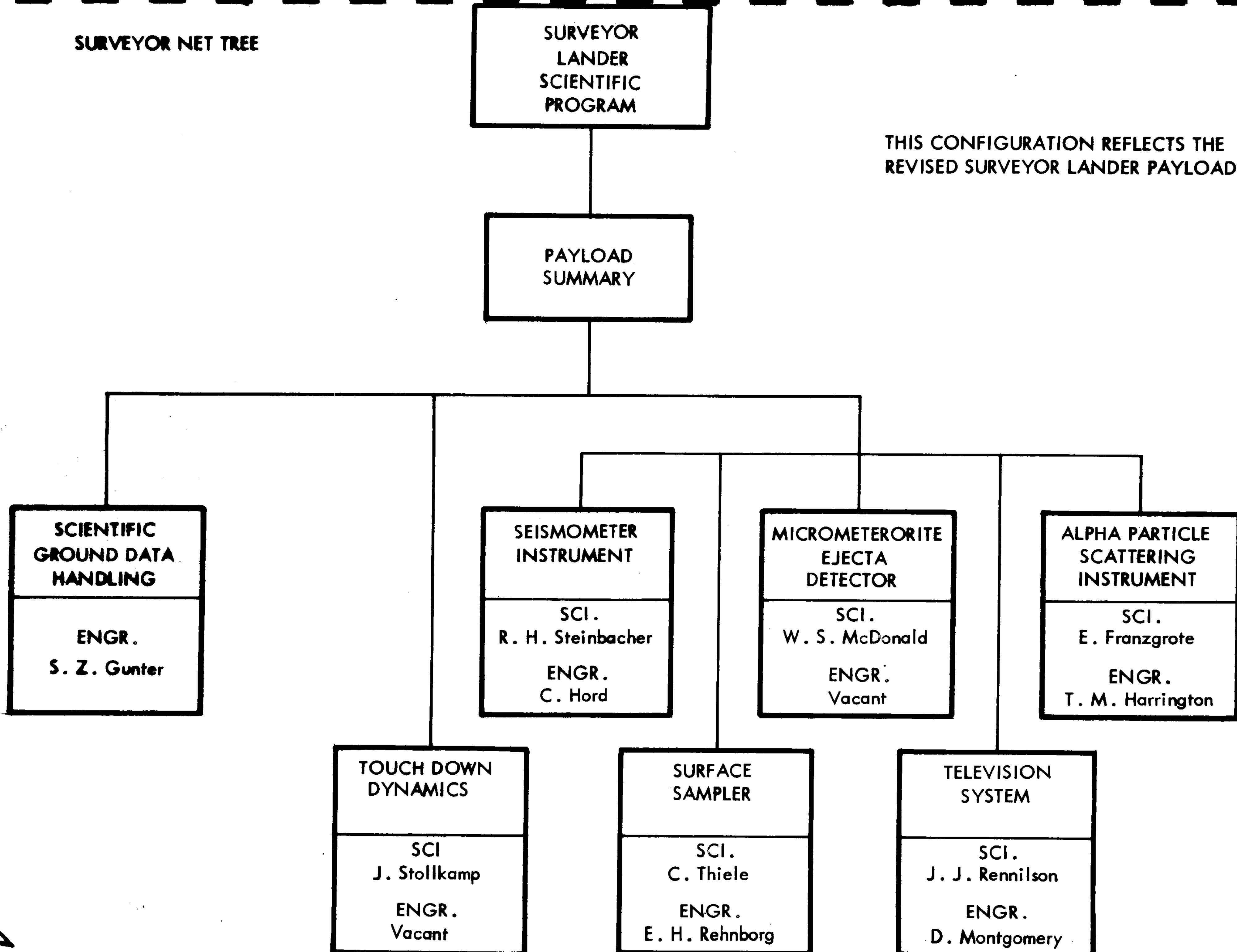
AGREEMENT

Proposed Outline

1. Objectives
2. Responsibilities
3. Experiment Description
    a. Rationale
4. Schedules
5. Specifications
6. Instrumention
    a. Procurment
    b. Integration
7. Tests
    a. Functional
    b. TAT & FAT
    c. Systems
8. Operations Requirements
    a. Data Processing
    b. Display
9. Post Flight Data Analysis
    a. Release of Data

SURVEYOR NET TREE

THIS CONFIGURATION REFLECTS THE REVISED SURVEYOR LANDER PAYLOAD.



SURVEYOR ALPHA SCATTERING FUNCTIONAL SPECIFICATION

EXPERIMENT OBJECTIVES

1. Perform elemental analyses of lunar surface material.

2. Assist in determining the nature and origin of the lunar material.

The analyses are accomplished by:

1. Identifying the mass numbers of elements present in the lunar material, by means of the energy spectrum of scattered alpha particles.

2. Additionally identifying certain lighter elements in the lunar material by means of the energy spectrum of protons emitted in alpha-proton nuclear reactions.

3. Determining the absolute abundances of elements in the lunar material by means of both of these spectra.

Alpha Scattering Instrumentation

In operation, alpha particles from a radioactive source bombard the sample. Some of the particles scattered from nuclei within the sample strike the surface of a small semiconductor detector placed at a high scattering angle. The amplified pulses from the detector are proportional to the energies of the incident alpha particles. The pulses are analyzed electronically and converted to digital representations of the energies. The digital numbers are telemetered to earth and decoded to reconstruct the energy spectrum of the scattered particles. The mass numbers of the nuclei within the target sample, as well as the abundances of these nuclei, can be determined from the energy spectrum.

The characteristic, stepped shape of the energy spectrum corresponds to the shape calculated from formulas for the stopping of charged particles. The high-energy cutoff is characteristic of the mass of the scattering nuclei. The intensity is mainly a function of the nuclear charge on the target nuclei. Resonant scattering effects result in enhanced intensities for certain lighter nuclei, including carbon and oxygen.

The analytical information contained in a complex spectra consists of the identification of elements from the position of breakpoints, and the determination of elemental abundances from the differences in height between plateaus.

A separate detector-analyzer system is used to obtain the energy spectrum of the protons. The proton detectors are covered with thin foils to stop scattered alpha particles, while allowing the more penetrating protons to pass. A separate 128 channel pulse height analyzer, amplifiers, and readout equipment is provided for the proton analysis. While the cross-sections for alpha-proton reactions are generally lower than those for alpha scattering, the potential analytical information contained in the spectrum is great because of its characteristic shape.

The elements detected by the alpha system include all elements with atomic number 5 (boron) or greater, and which exceed one per cent by weight in the sample.

The proton system is capable of analyzing lithium, boron, nitrogen, fluorine, sodium, magnesium, aluminum, silicon, phosphorus, and sulfur.

Analysis of multicomponent samples is obtained by comparing the spectrum with standard spectra of individual elements and obtaining the best fit. This is based on a least squares criterion, using a computer program developed for the 7090. The alpha and proton data are combined analytically to provide automatic cross-correlation of the two types of information.

SURVEYOR SEISMOMETER FUNCTIONAL SPECIFICATION

EXPERIMENT OBJECTIVES

1. Seismic activity - number, magnitude, and spacial distribution of natural moonquakes.

2. Background noise level - spectrum of the background noise, correlated with thermal and other (including spacecraft) sources.

3. Effect of temperature on lunar surface materials.

4. Elastic properties and structure:
   - near-surface - from body waves and short period surface waves;
   - at depth - from body waves, intermediate-period surface waves, free oscillations, and tides.

5. Internal constitution - internal damping or Q, density versus depth, temperature versus depth, type and state of lunar material versus depth.

6. Distribution of meteorite impacts - number and energy released; (dependant upon the ability to discriminate between impacts and moonquakes).

SURVEYOR SOIL MECHANICS FUNCTIONAL SPECIFICATION

EXPERIMENT OBJECTIVES

1. Identify the lunar surface model in terms of materials and configurations.

2. Determine the mechanical properties of the lunar surface material in terms of modulus of elasticity, for rock-like materials, and rupture, yield, or shear strength, for soil-like materials.

3. Identify the mechanical properties of each layer of surface material, if the model consists of more than one layer within the depth of investigation of the instrumentation.

Lunar surface models may be categorized in terms of continuous or discontinuous materials. Continuous materials are rock-like, either incompressible or compressible, and may be porous.

Discontinuous materials are granular or soil-like. They may be cohesionless in which no intrinsic force exists between particles, and stresses at points of contact result from external forces only, such as gravity and surface structure. An adhesive soil may result in a medium in which particles adhere to one another. In a cohesive soil, particles attract one another, and may adhere at points of contact; stresses at contacts are a net result of external compressive and intrinsic attractive forces. Finally, a repulsive soil may exist, in which a net repulsive force exists between particles from external compressive and intrinsic repulsive forces.

Particles in these granular soil models may be of any shape. It is likely that the size of the cohesive and repulsive soil particles will be small, on the order of micron s or less. Cohesionless and adhesive soil particles may be of any size.

With respect to configuration, soil models may be divided into three groups; homogeneous, layered, or heterogeneous. Homogeneous models include both continuous and granular material, such as uniform rock or soil within the area tested. Layered models include various layering of continuous and/or granular material. Heterogeneous models are composed of random mixtures of continuous and granular materials, such as soil interspersed with fragments of solid rock.

Lunar soil mechanics experiments include:

1. Visual observation of the interaction between the spacecraft (including landing pads, crushable structures, etc.) and the lunar surface.

2. Visual observation and qualitative monitoring of the response of the lunar surface to stress or energy applied by spacecraft instruments. This includes radiational, chemical and mechanical energy. Because of characteristic material behaviors, information on the nature of the surface, and qualitative mechanical properties, can be deduced from these experiments. Mechanical tests include touching, prodding, or scraping the surface with visual observation; or, dropping projectiles and/or firing jets at the surface and observing bouncing and cratering behavior.

3. Visual observation and quantitative measurements of the response of the lunar surface to static penetration, static shear, and dynamic penetration. Included in this category are: application of a known load to a bearing plate, or point, and measuring surface penetration; measuring the shear load, normal load, and surface penetration of a shearing device; determining the deceleration-time history of an instrumented projectile; and, drilling into the lunar surface with a known load, and measuring penetration versus time.

Instrumentation for the soil mechanics experiment includes:

1. Surface sampler, preferably instrumented for static and dynamic measurements. For initial Surveyor flight missions, it is preferable to explore the lunar surface in the vicinity of the spacecraft, in as many locations as possible. Consequently, the surface sampler is of potential soil mechanics value, and will be instrumented as follows:
   a. azimuth and elevation displacement readout of scraper position with an accuracy of $\pm$ 0.1 inch at or below the surface, and 1.0 inch above the surface.
   b. strain gauges to measure horizontal and vertical forces applied to the surface in the 0.1 to 30 psi range, as the scraper is pulled toward the spacecraft.
   c. accelerometers mounted on the scraper blade, sensitive in the 0 to 50 G, and 0 to 2000 G ranges, for deceleration-time history measurements when the sampler is used as a pick.
   d. stripe or gridwork markings on the observable surfaces of the scraper, to measure depth of penetration, grain size, and soil level in the bucket, by television observation.

2. Bearing plates for static penetration measurements, with or without a shearing device.

3. Accelerometers or drop penetrometers to measure the mechanical properties of the impacted surface, by the deceleration-time behavior of the projectile.

SURVEYOR TELEVISION FUNCTIONAL SPECIFICATION

EXPERIMENT OBJECTIVES

General:

1. Obtain pictures during the approach-descent of the spacecraft to the lunar surface to determine the position of the landing site and improve the knowledge of the topography and geology in the area immediately surrounding the landing point.

2. As principal function, survey the vicinity of the landing point.

3. Monitor the operation, on the lunar surface, of instruments carried by the spacecraft.

Detailed:

Lunar Approach Pictures

1. Identify the landing point in lunar coordinates and correlate with existing information, maps, and photographs of the moon.

2. Relate the landing point to known positional features observed in the approach pictures.

3. Provide a general concept of the geology and topography in the vicinity of the landing site.

4. Relate the differential photometric information from the approach pictures with terrestrially obtained information.

5. Reveal details, and extend measurements of lunar surface relief and photometry by providing photographic information of higher resolution than is possible from earth.

6. Aid in optimizing the sequence and interpretation of the lunar survey pictures.

Lunar Survey Pictures

1. As primary function, provide panoramic photographic information of the visible lunar terrain in the immediate vicinity of the spacecraft, up to and including the local horizon.

2. Provide measurements of feature size, shape, and range, through photogrammetry.

3. Produce topographic or form-line maps of the observable vicinity of the spacecraft, for use in interpreting the geologic features.

4. Provide photometric, colorimetric, and polarimetric measurements of selected regions of the visible lunar surface, to aid in differentiating the observed features.

5. Provide information on the relation between photometric, colorimetric, polarimetric measurements and feature size and range.

6. Observe the lunar surface features at different angles of solar illumination to assist in differentiating and correlating the visual information, in identifying the lunar surface features, and in enhancing the topographic measurements.

7. Accurately locate the spacecraft lunar landing site by stellar position measurements.

Observation of Instruments

1. Monitor the operation of the scientific instruments.

2. Assist other Experimenters during instrument operation and the interpretation of data.

3. Obtain photogrammetric (object size, shape, and range), photometric, colorimetric, and polarimetric measurements in the areas disturbed by instrument operation.

4. In cooperation with the Soil Mechanics Experimenter, investigate details of lunar surface response to applied stress, by evaluating pictures taken before and after instrument operation.

5. In cooperation with other Experimenters, relate mineralogical and chemical analyses to lunar surface properties which have been distinguished by the television experiment in areas sampled and tested by these instruments.

6. Extend these analyses to visible areas beyond the sampling range of the spacecraft; in particular, relate the properties of the analyis area with visual properties of the lunar surface, as displayed on topographic and geologic maps.

SURVEYOR MICROMETEORITE FUNCTIONAL SPECIFICATION

EXPERIMENT OBJECTIVES

1. Measure the number, mass, speed, and trajectory of individual micrometeorite and ejecta particles at the lunar surface.

2. Discriminate between primary micrometeorite particles impacting the lunar surface, and ejecta particles thrown out by the impact.

3. Evaluate the influx rate of interplanetary material on the lunar surface.

4. Evaluate the enhancement of the primary influx rate by the ejecta phenomena at the lunar surface.

5. Recognize and study ejecta from a single micrometeorite impact event by measurements of time and trajectory relationships between individual ejecta particles.

6. Assist in the study of the nature of the lunar surface, as determined by the interaction between the surface and the impacting particles.

7. Contribute to the study of the evolutionary processes of the moon.

8. Investigate the contribution of lunar ejecta material to the dust distributions in interplanetary, cis-lunar, and near-earth space.

9. Evaluate the hazard confronting manned and unmanned explorations of the lunar surface.

Micrometeorite Ejecta Detector Instrumentation

Two sensors, placed on opposite sides of the spacecraft with axes elevated 30 degrees with respect to the horizontal, measure the momentum and velocity of dust particles. Each sensor consists of a front film matrix, a rear film matrix, and an impact plate.

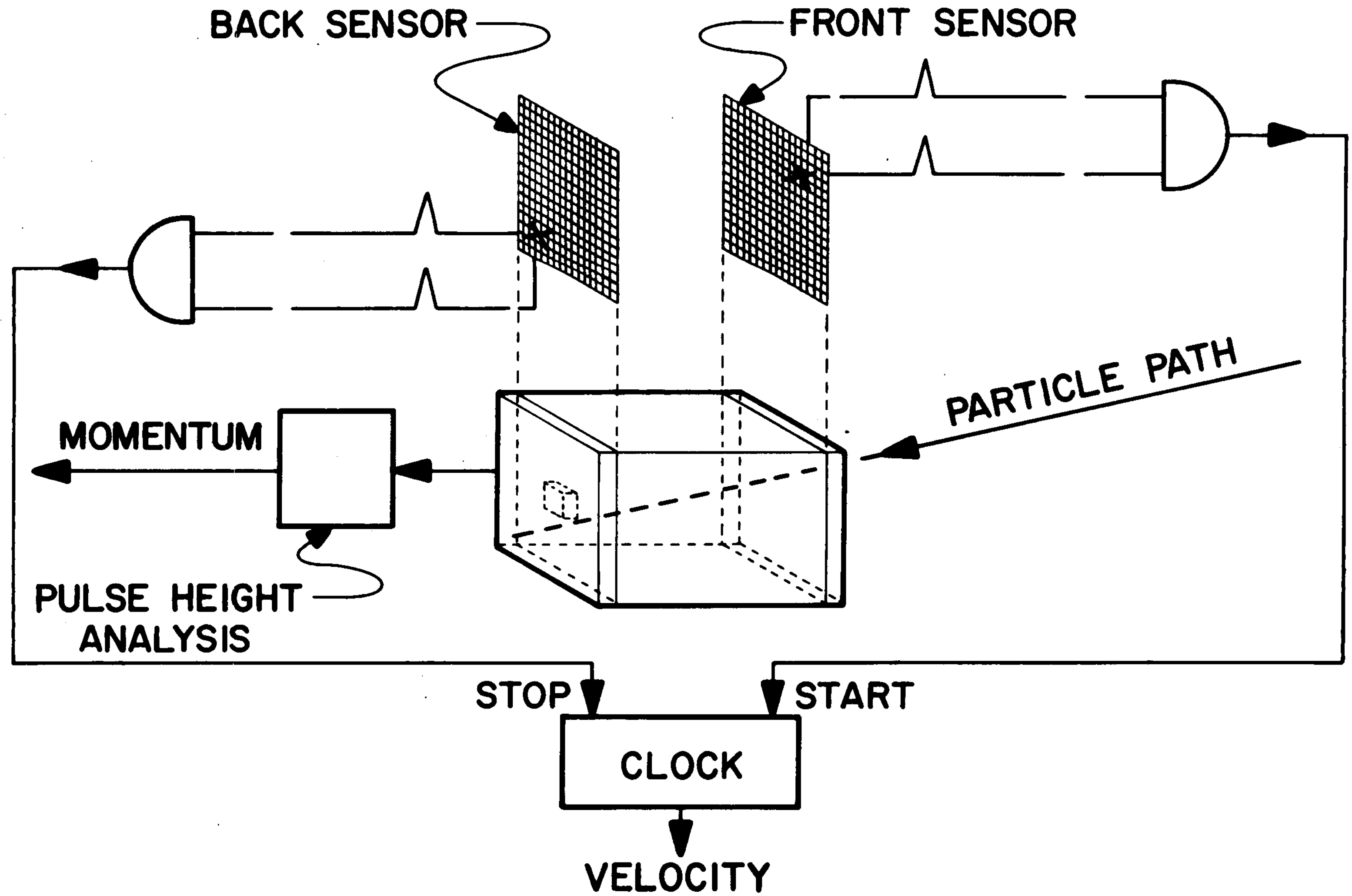
Both film matrices are formed by a dielectric which separates multiple rows of conductive material on one side from multiple columns on the other. The front film is suspended at a distance from the rear film, which is bonded to a dielectric and mounted on the impact plate. An acoustical transducer is mounted on the rear of the impact plate.

When a particle passes through the front film, two signals are generated. These are of opposite polarities and correspond to the row and column at the point penetrated by the particle. The same signals occur at the rear film, thus determining the particle radiant within the sensor. The signal from the front film starts a clock which is stopped by the signal from the rear film. Thus the time of flight is measured and the velocity determined.

The amplifier for the acoustical detector has a voltage gain of approximately 10^5, with an output signal which is proportional to the particle momentum. Pulse height analysis takes place over six decades of momentum, and is stored until readout. The pulse height analysis is divided into 14, logarithmically spaced windows in the first four decades. The remaining two binary states correspond to the two decades of momentum sensitivity at the high end of the scale. The design goal for momentum sensitivity threshold is 10^{-5} dyne seconds.

The sensors are calibrated on command by impulses which simulate film penetration locations, time of flight, and impact. In case a short circuit occurs between the front and rear conductor of any film, a matrix clear command is provided.

MICRO METEORITE EJECTA DETECTOR

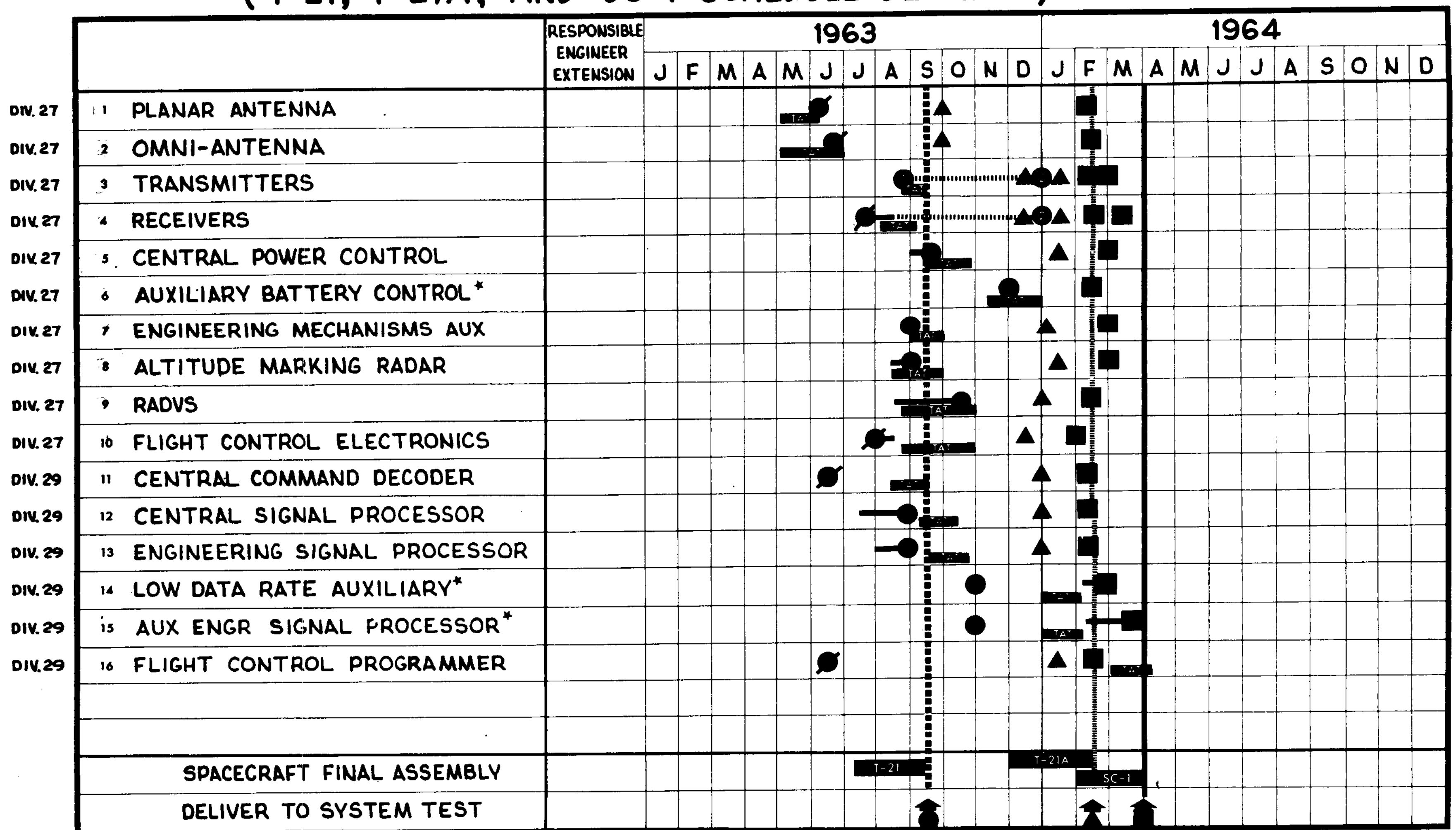


56
A

TOUCHDOWN DYNAMICS INSTRUMENTATION

- STRAIN GAUGES
  - EACH RIGID LANDING–GEAR MEMBER (2) 6
  - EACH SHOCK ABSORBER (1) 3
- POTENTIOMETERS
  - EACH SHOCK ABSORBER (INDICATE DISPLACEMENT) 3
- ACCELEROMETERS
  - SENSITIVE ALONG *X*, *Y*, & *Z* AXIS 3
- RATE GYROS
  - SENSITIVE ABOUT *X*, *Y*, & *Z* AXIS 3
- TOTAL SENSORS (& DATA CHANNELS) 18
- BANDWIDTH, EACH CHANNEL: 0–25 cps

BASIC BUS-ELECTRONICS
(T-21, T-21A, AND SC-1 SCHEDULE DETAILS)



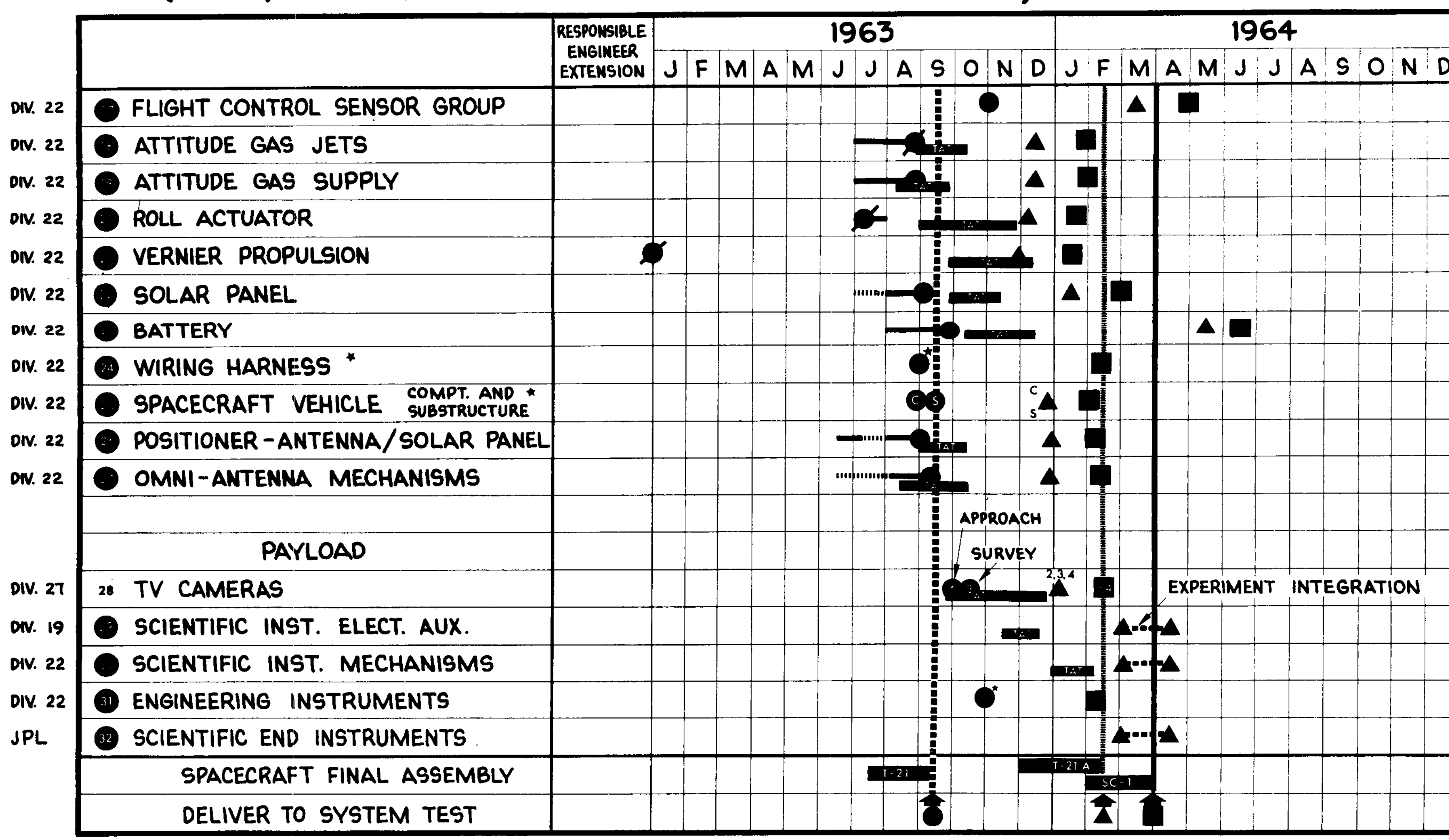
AUGUST 26, 1963

● T-21
▲ T-21A
■ SC-1
★ C.O. 18 EFFECT ON T-21
▬ SLIP FROM 10 MAY EST. TO JPL
┅ PROG. ADJ. SINCE 10 MAY EST. TO JPL

59

BASIC BUS (EXCEPT ELECTRONICS) AND PAYLOAD
(T-21, T-21A, AND SC-1 SCHEDULE DETAILS)

HUGHES
HUGHES AIRCRAFT COMPANY
SPACE SYSTEMS DIVISION



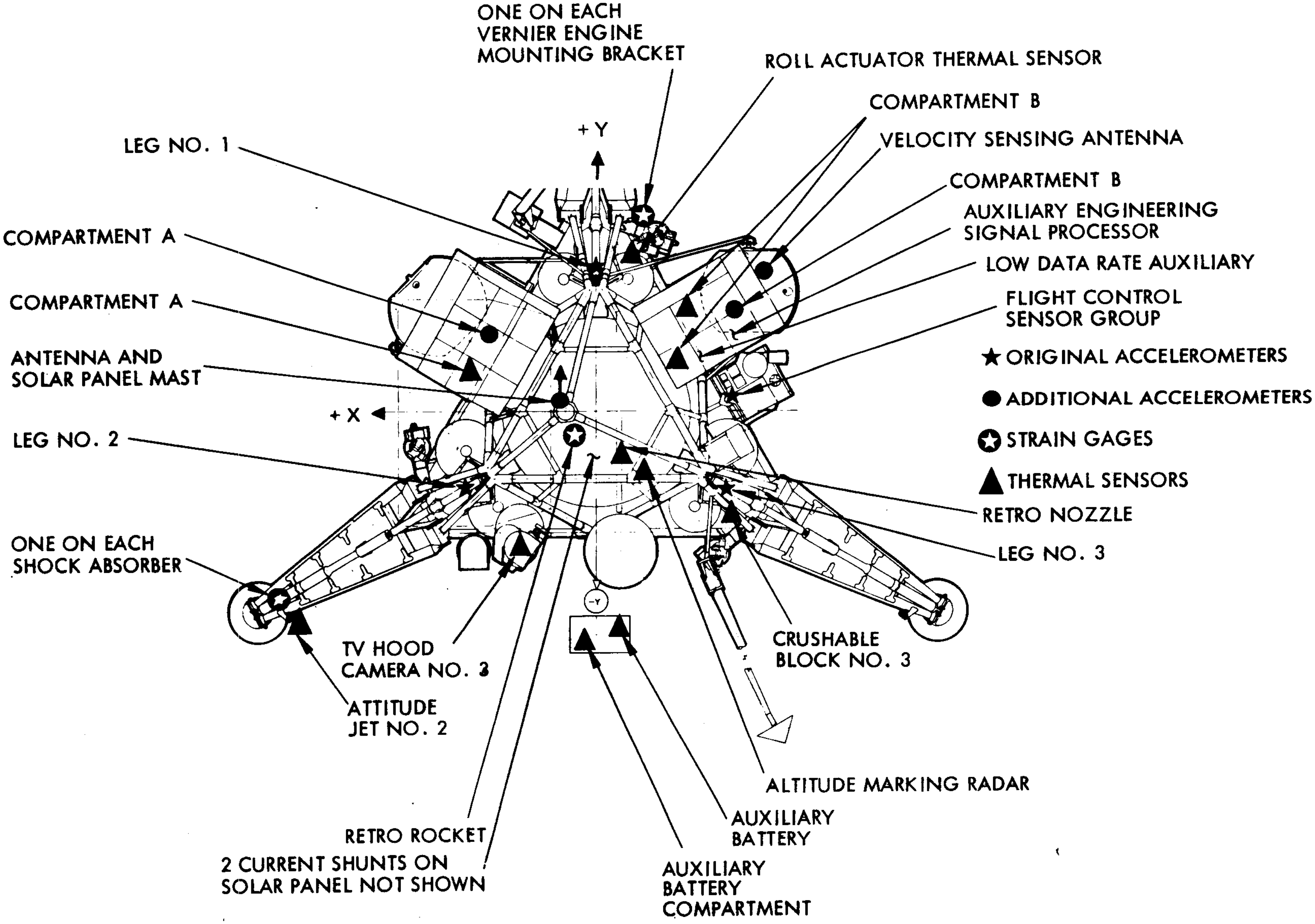
● T-21
▲ T-21A
■ SC-1
* C.O. 18 EFFECT ON T-21
▬ SLIP FROM 10 MAY EST. TO JPL
┅ PROG. ADJ. SINCE 10 MAY EST. TO JPL

AUGUST 26, 1963

ENGINEERING INSTRUMENTATION SUMMARY

SUBSYSTEM	CONTRACT PHASE / DATE: MOD. 6/JUN 1961	MOD. 15/OCT 1962	CHANGE ORDER 18/MAY 1963	
	ALLOCATION: BASIC BUS	PAYLOAD: SUPPLEMENT NO. 1	PAYLOAD: SUPPLEMENT NO. 2	TOTAL
	WEIGHT (INCLUDING WIRING): 9.2	4.2	4.5	17.9
SPACECRAFT VEHICLE AND MECHANISMS	• LANDING GEAR: POSITION • SPACE FRAME: ACCELEROMETERS (4) • OMNI-ANTENNA: POSITION • PLANAR ANTENNA: POSITION • SOLAR PANEL: POSITION • RETRO ENGINE: SEPARATION SENSOR • THERMAL (6)	(12)	STRAIN GAUGE ON SHOCK STRUT • COMPARTMENT: ACCELEROMETER (2) • MAST: ACCELEROMETER (1) (5)	
PROPULSION	• VERNIER: H_e TANK PRESSURE • THERMAL (7)	FUEL MANIFOLD PRESSURE (8)	STRAIN GAUGE ON ATTACH BRACKET • MAIN RETRO: STRAIN GAUGE ON CASE (1)	
FLIGHT CONTROL (ϵ = ERROR SIGNAL)	• GYROS: ϵ, WHEEL SPEED, PRECESSION DIRECTION • SUN SENSORS: ϵ, LOCK ON • CANOPUS SENSOR: ϵ, INTENSITY, LOCK ON • ACCELEROMETER: ϵ, AND MAGNITUDE • PROGRAMMER: RETRO IGNITION, RETRO EJECT, GYRO PRECISION SIGNAL, SWITCHING STATE (8), VERNIER THRUST SIGNAL • GAS JETS: SUPPLY PRESSURE • RADVS: RANGE AND VELOCITY, AMPLITUDE, MARK SIGNAL AT 10 FPS, 1000 ft AND 13 ft • ALT. MARK. RADAR: RADAR ON, AGC • THERMAL (8)	• ROLL ACTUATOR: INPUT SIGNAL THRUST PHASE POWER ON, VERNIER ENGINE IGNITION SIGNAL, SWITCHING STATE (3) DOPPLER BEAM RELIABLE SIGNAL, RANGE AND DOPPLER GAIN ENABLE VERIFICATION AND MAGNETRON CURRENT (5)	SECONDARY SUN SENSOR LOCK ON ANTENNA ACCELEROMETER (3)	
ELECTRIC POWER	• SOLAR PANEL: VOLTAGE, CURRENT, AND TEMPERATURE • BATTERY: VOLTAGE, CURRENT, AND TEMPERATURE • CENTRAL POWER CONTROL: REGULATOR VOLTAGE	CHARGE REGULATOR AND BUS CURRENTS	LOCK, CURRENT, BACK PANEL TEMPERATURE	
TELECOMMUNICATIONS	• TRANSMITTERS: FILAMENT ON • RECEIVER: AGC • TRANSPONDER: PHASE LOCK AND ERROR • CENTRAL DECODER: STATE, MESSAGE REJECT AND ENABLE • SIGNAL PROCESSOR: REFERENCE VOLTAGE AND RETURN • THERMAL (2)	POWER OUTPUT AFC		
T.V. NO. 4	• POWER: ON SIGNAL • VIDICON: THERMAL CONTROL ON SIGNAL • THERMAL (2)			

ENGINEERING PAYLOAD SENSORS
SC—I THROUGH SC—4



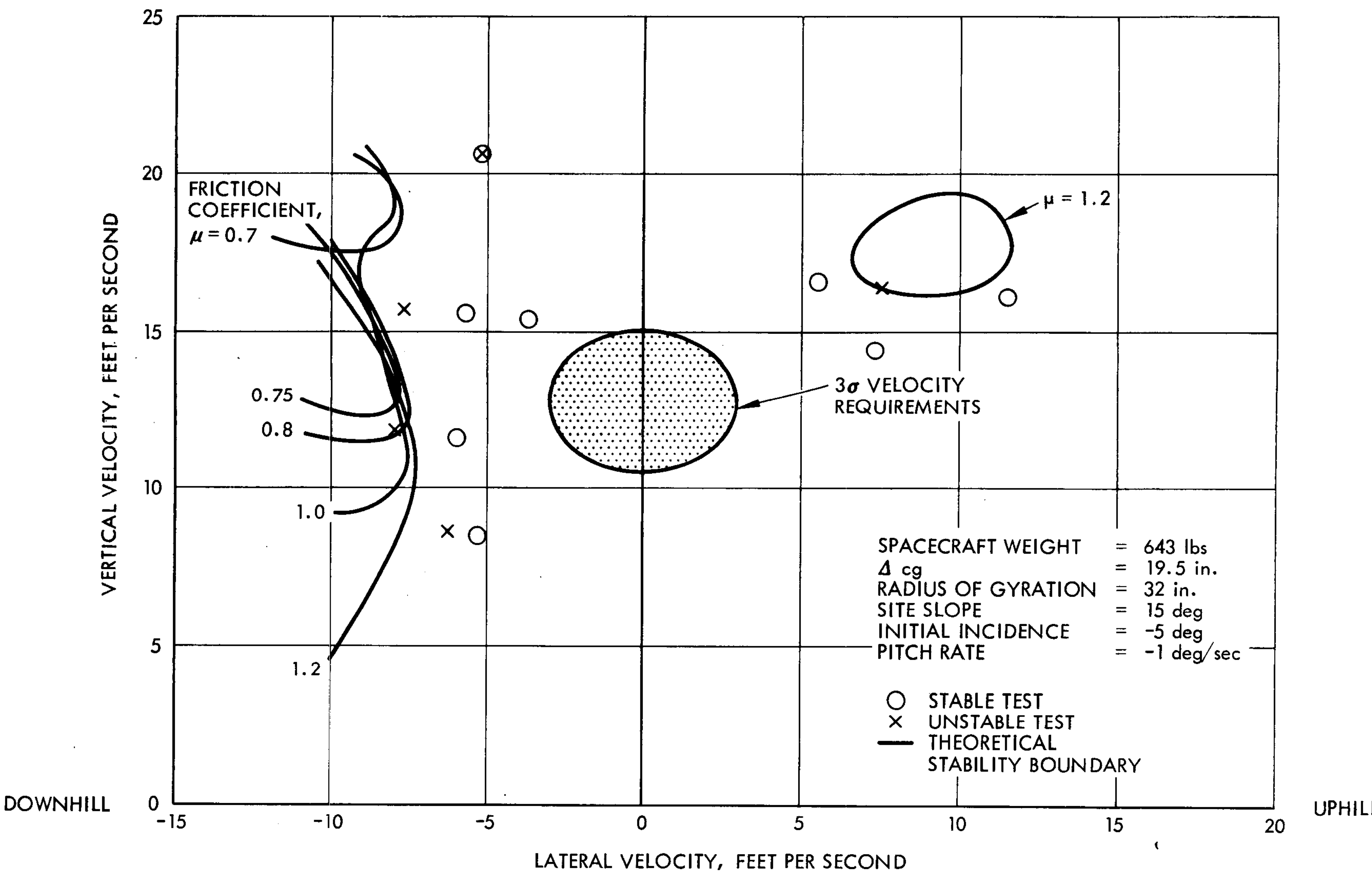
FAILURE MODE STUDY SCHEDULE

NONSTANDARD PROCEDURE	COMPLETION DATE 1963 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DESIGN IMPLICATIONS OR CHANGES EFFECTED
CANOPUS SENSOR	▲												CANOPUS LOCKON LOGIC CHANGE
SOLAR PANEL POSITIONING	▲												SOLAR PANEL LOCK TELEMETRY REQUESTED
SOLAR PANEL ELECTRICAL	▲												
PRIMARY AND SECONDARY SUN SENSOR		▲											SUN LOCKON SIGNAL TELEMETRY REQUESTED
LANDING GEAR MECHANISM		▲											OMNIDIRECTIONAL ANTENNA EXTENSION MECHANIZATION CHANGE REQUESTED
OMNI-ANTENNA MECHANISM AND ELECTRONICS		▲											
FLIGHT CONTROL-COAST PHASE			▲										FLIGHT CONTROL PROGRAMMER REDESIGN
ONE-WAY ACQUISITION			▲										
TWO-WAY ACQUISITION			▲										
PRETHRUST ATTITUDE MANEUVER				▲									
FLIGHT CONTROL-THRUST PHASE				▲									
STANDARD ATTITUDE MANEUVER				▲									
COMMAND/TRANSPONDER SYSTEM					▲								
TERMINAL DESCENT						▲							INCORPORATED MANUAL RETRO IGNITION AND SEPARATION
PLANAR ARRAY ORIENTATION AND DESCENT TV							△						
POWER MANAGEMENT								△					
EMERGENCY RETRO SEQUENCE							△						
CENTAUR SEPARATION								△					
SOLAR PANEL NOT IN TRANSIT POSITION									△				
COAST PHASE ROLL CONTROL										△			
CONSERVATION OF BATTERY ENERGY											△		
PLANAR ARRAY AS ROLL ATTITUDE REFERENCE											△		
FLIGHT CONTROL PROGRAMMER												△	

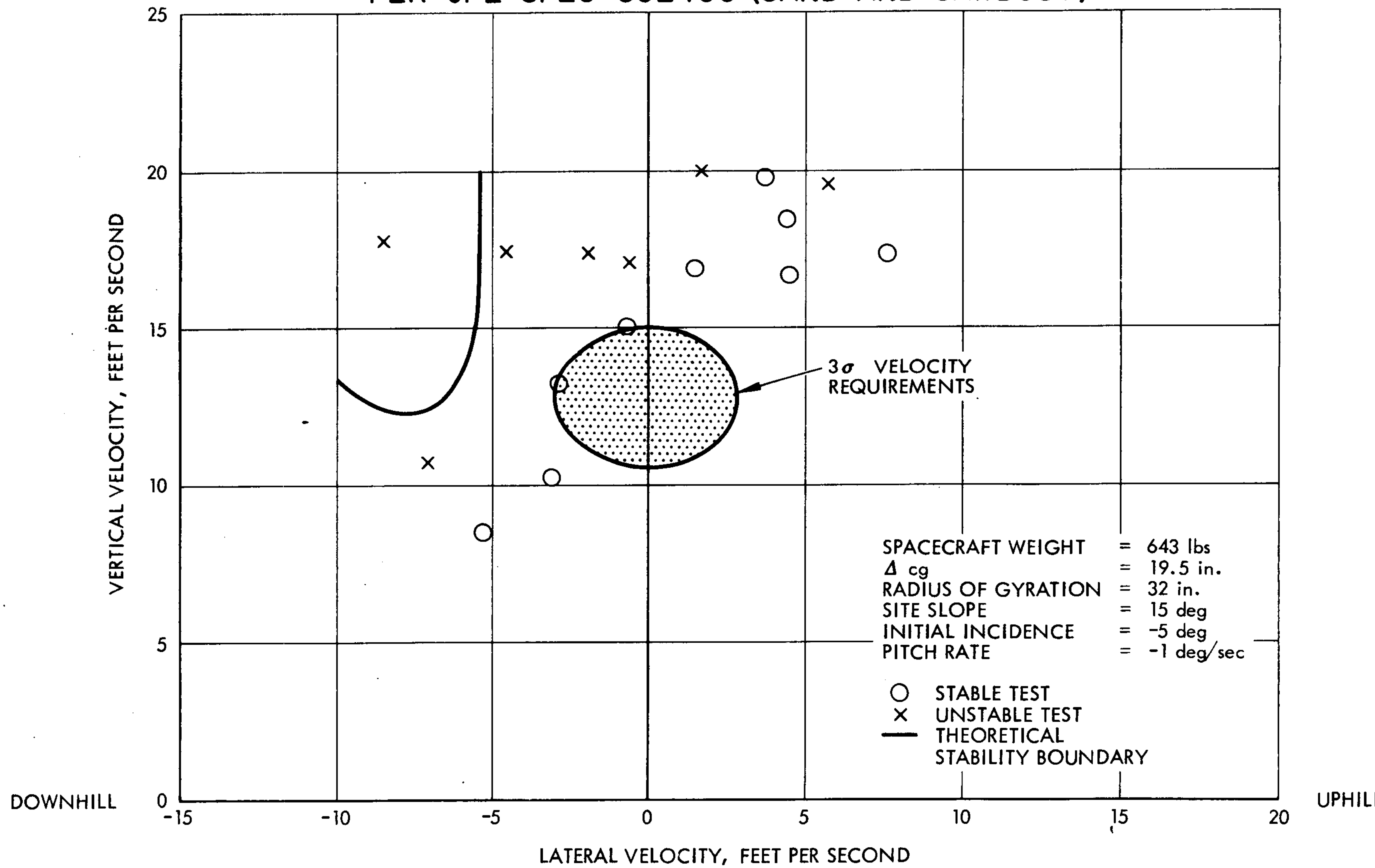
▲ COMPLETED

△ PLANNED

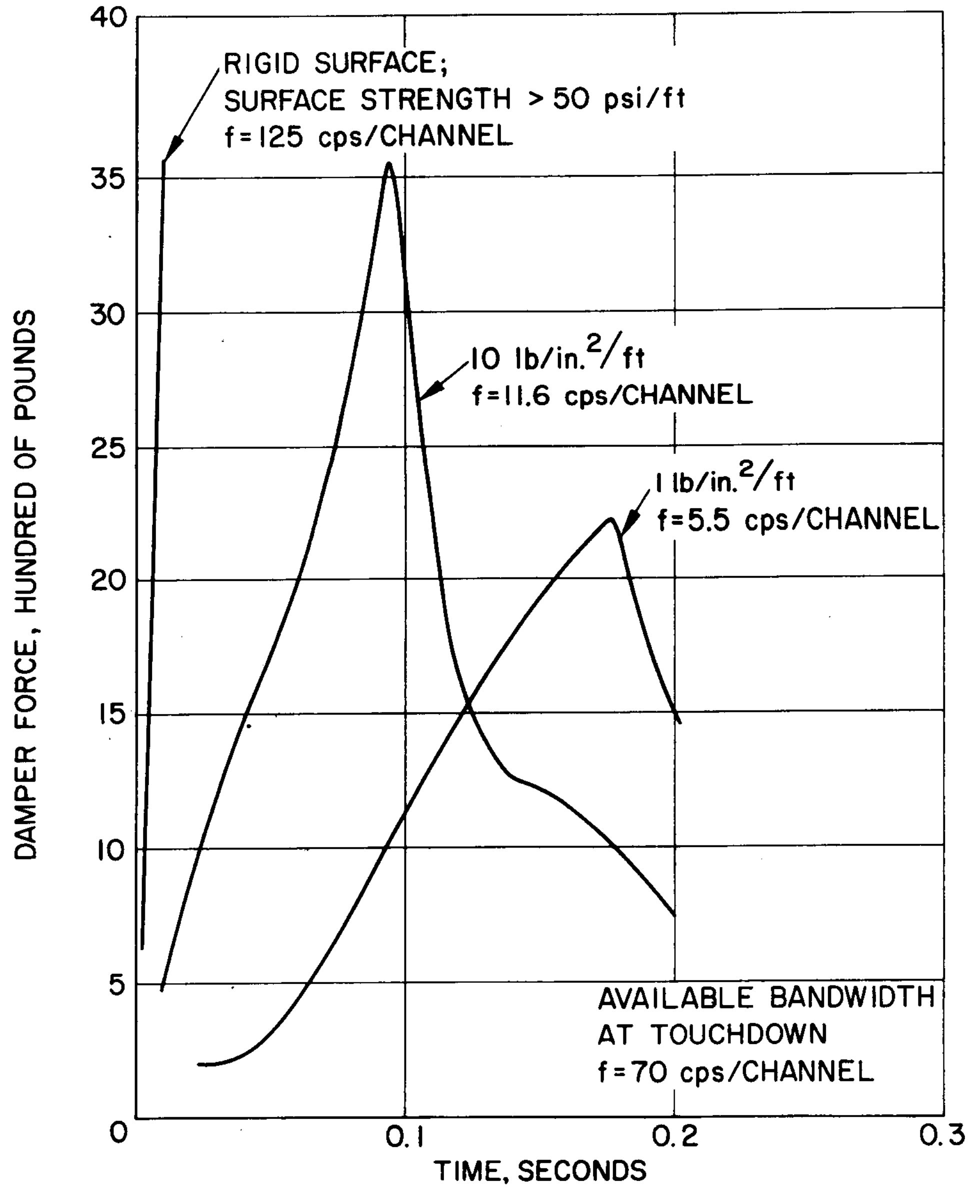
T-I (A-21) DROP TEST ON HARD ROCKY SURFACE



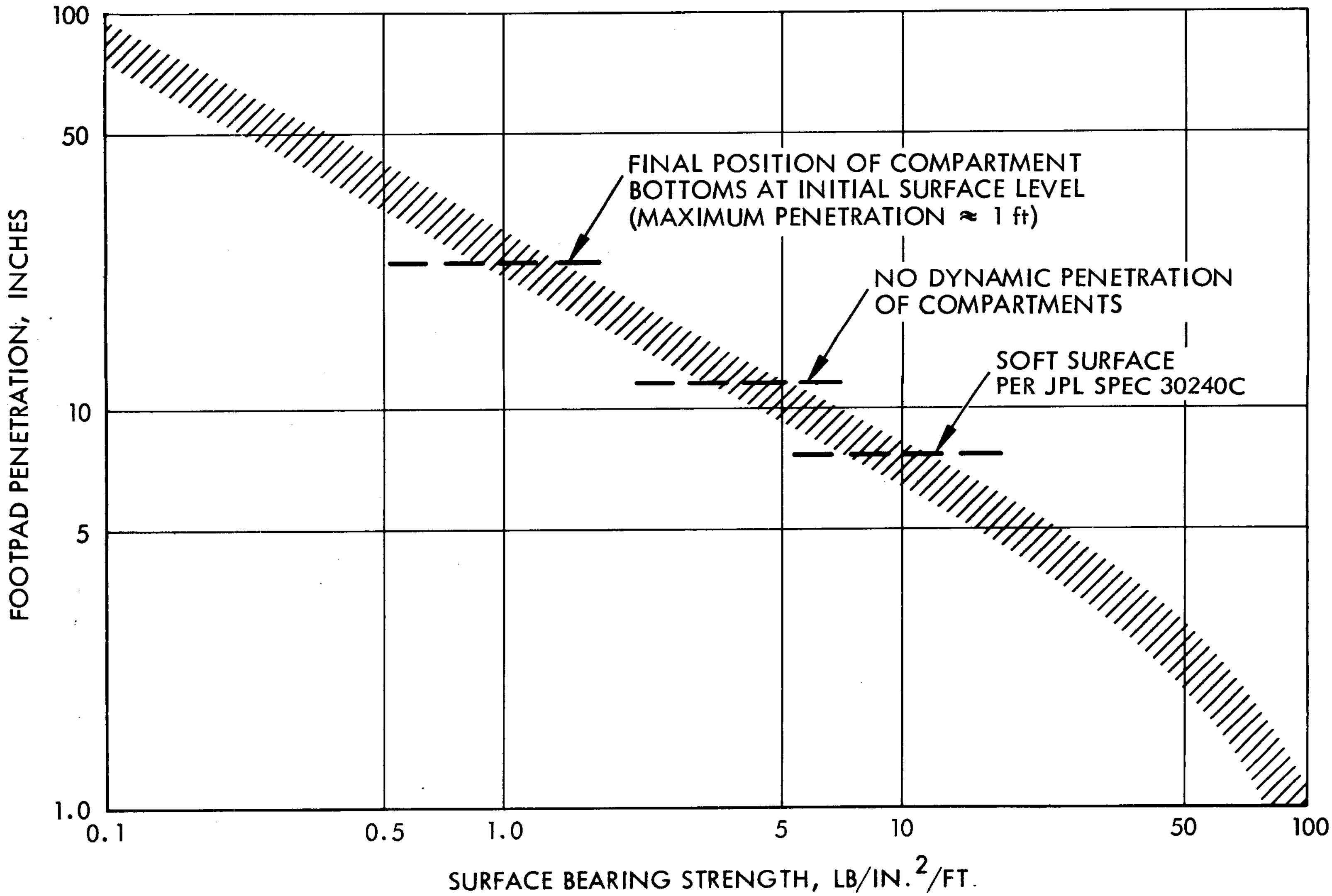
T-1 (A-21) DROP TEST ON SOFT SURFACE
PER JPL SPEC 30240C (SAND AND SAWDUST)



SHOCK ABSORBER FORCE AND
REQUIRED COMMUNICATIONS BANDWIDTH
20 FPS NORMAL IMPACT



FOOTPAD PENETRATION
TOUCHDOWN VERTICAL VELOCITY = 20 FPS



TEST AND PREDICTED TRANSIT TEMPERATURES

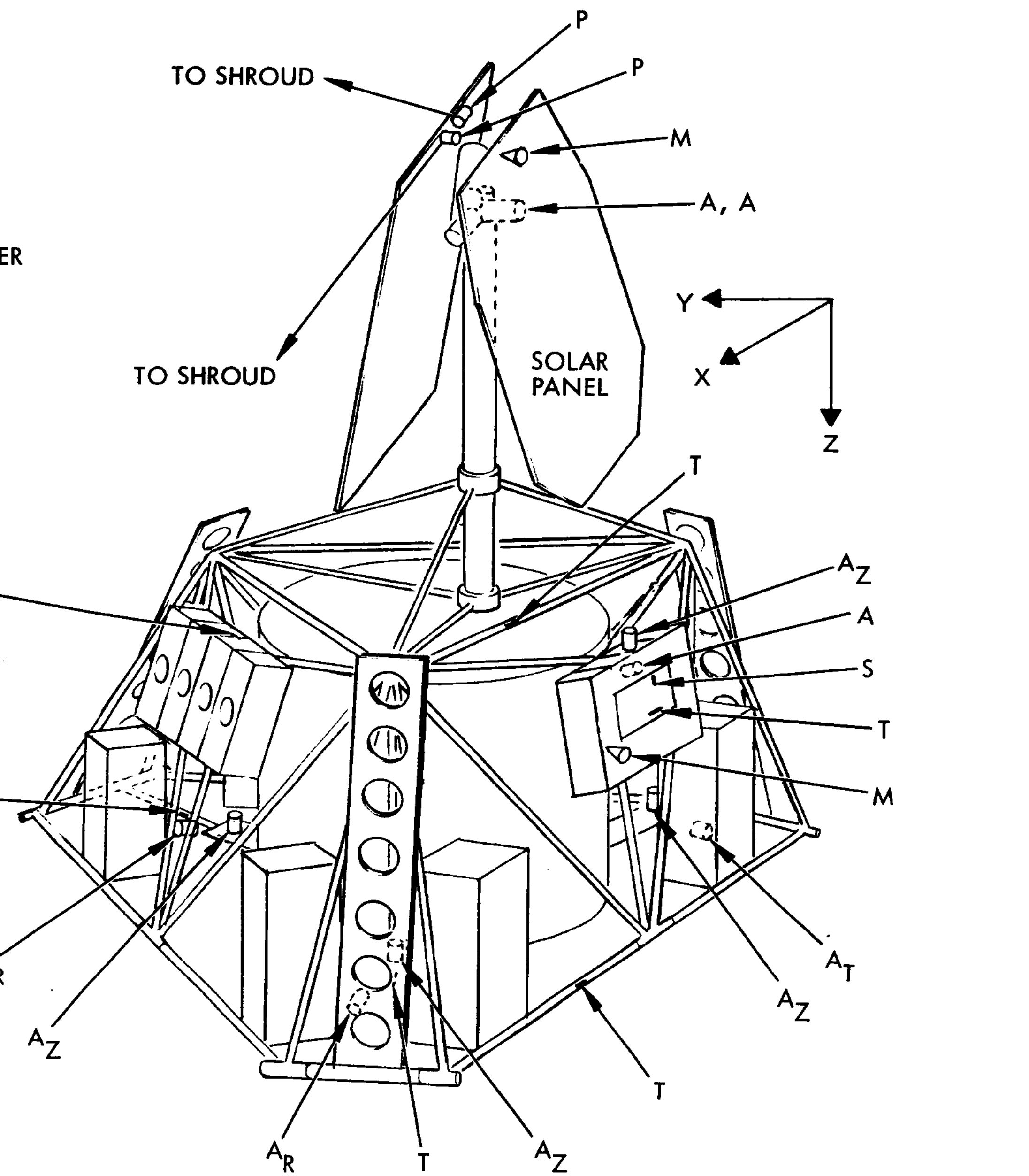
MT-I SECTOR II

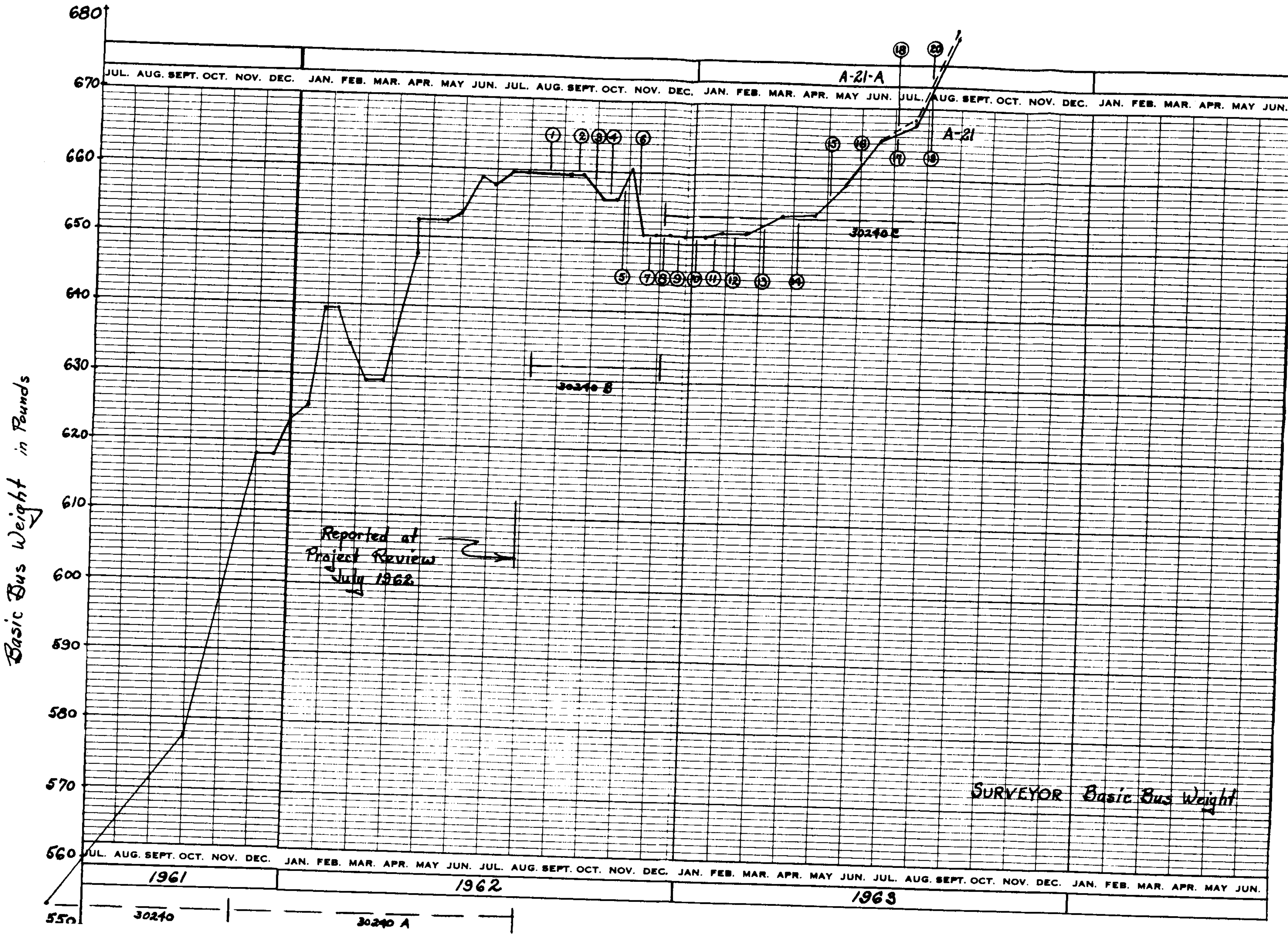
MT-1 SECTOR II SUBSYSTEM	TEMPERATURE REQUIREMENT, °F	TEST NO. 1 TEMPERATURES, °F PREDICTED 100% INTENSITY	TEST NO. 1 TEMPERATURES, °F TEST 100% ± 15% INTENSITY	TEST NO. 2 TEMPERATURES, °F PREDICTED 100% INTENSITY	TEST NO. 2 TEMPERATURES, °F PREDICTED 85% INTENSITY	TEST NO. 2 TEMPERATURES, °F TEST 85% ± 3% INTENSITY
1 COMPARTMENT B						
SWITCH RADIATORS	—	54	75 TO 93	66 TO 82*	50 TO 66*	54 TO 64*
THERMAL TRAY	0 TO 125	85 TO 87*	98 TO 108*	—	—	—
2 VERNIER SYSTEM						
VERNIER ENGINE	0 TO 100	55 TO 63	149 TO 161	54 TO 101	40 TO 85	25 TO 75
FUEL TANK (PAINTED)	0 TO 100	80 TO 130	123 TO 159	63 TO 98	47 TO 82	42 TO 68
OXIDIZER TANK (PAINTED)	0 TO 100	80	72	23 TO 103	17 TO 88	40 TO 50
3 FCSG						
CANOPUS RADIATOR	—	47	126	66	—	100
CANOPUS BASE, INTERNAL	-20 TO 125	65	115	69	—	99
CANOPUS SUN SHADE	—	-22	31	-10	—	25
SUN SENSOR	35 TO 120	69	9	66	—	81
MOUNTING PLATE	0 TO 140	69	100	66	—	77
IRU RADIATOR	—	150	150	155 TO 165	—	162
IRU GYRO MOUNTING RING	180 ± 2	170 TO 180	—	170 TO 180	—	173
4 RADVS						
VELOCITY SENSOR ANTENNA DISH	-250 TO 250	23 TO 68	52 TO 68	-29 TO 145	-46 TO 130	-28 TO 76
VELOCITY SENSOR ANTENNA SEPTUM	-250 TO 250	-190 TO 130	38	-190 TO 130	-190 TO 120	13
SIGNAL DATA CONVERTER	40 TO 78	15 TO 65	140 TO 179	28 TO 53	7 TO 30	12 TO 30
5 TV CAMERA NO. 2	7 - 200	-76	-16 TO 9	—	—	-60
6 SPACE FRAME						
UPPER	-120 TO 100	-62 TO -22	-55 TO 70	-50 TO 0	—	-60 TO 7
LOWER	-140 TO 100	-12 TO 123	-35 TO 73	-20 TO 40	—	0 TO 35

*AT 15 WATTS

DYNAMIC MODEL SD-4 CONFIGURATION

A = ACCELEROMETER
S = STRAIN GAGE
T = TEMPERATURE SENSOR
P = POSITION POTENTIOMETER
M = MICROPHONE





69

26 Aug. 1963

26 August 1963
GV:hr

SURVEYOR

Major items contributing to changes in basic bus weights:

①	27 July '62 to 7 September '62	(659.8) to (659.21)	-.59
	No major items		
②	7 September '62 to 21 September '62	(659.21) to (659.21)	.0
③	21 September '62 to 5 October '62	(659.21) to (656.10)	-3.10
	Recalculation of unusable propellant requirements.		
④	5 October '62 to 19 October '62	(656.10) to (656.10)	.0
⑤	19 October '62 to 2 November '62	(656.10 to (660.56)	+4.46
	Actual weight of Canopus sensor	(+.55)	
	Electronics	(+1.55)	
	Wiring harness--recalculation	(+1.70)	
	Vernier engine system hardware	(+.66)	
⑥	2 November '62 to 16 November '62	(660.56) to (651.06)	-9.50
	Main retro case--		
	remove excess material	(-1.80)	
	remove portions of internal insulation	(-4.00)	
	change closure from steel to ab.	(-3.70)	
⑦	16 November '62 to 30 November '62	(651.06) to (651.06)	..0
⑧	30 November '62 to 14 December '62	(651.06) to (651.20)	+.14
	No major items.		
⑨	14 December '62 to 28 December '62	(651.20) to (651.20)	.0
⑩	28 December '62 to 11 January '63	(651.20) to (651.20)	.0
⑪	11 January '63 to 25 January '63	(651.20) to (651.78)	+.58
	No major items.		
⑫	25 January '63 to 22 February '63	(651.78) to (651.78)	.0

26 August 1963
GV:hr

Basic bus weights -

13	22 February '63 to 22 March '63	(651.78) to (654.14)	+2.36
	Spacecraft vehicle		
	wiring harness-based on actual and revised T-21 calculations	(+2.25)	
	vernier tank insulation	(+ .97)	
	vernier engine #2 heat collector	(+ .78)	
	main retro insulation removed	(-2.10)	
14	22 March '63 to 19 April '63	(654.14) to (654.49)	+.35
	Flight control sensor group		
	increased stiffness to meet vibration	(+.35)	
15	19 April '63 to 17 May '63	(654.49) to (659.08)	+4.59
	Flight control - Canopus sensor	(+.12)	
	electronics	(+.34)	
	Electronics - transmitters A & B	(+.78)	
	AMR	(+.27)	
	Spacecraft vehicle -		
	- installation hardware TV #4 and He tank	(+1.09)	
	- wiring harness	(+ .26)	
	Propulsion - disconnects added	(+1.10)	
	- thrust chamber	(+ .24)	
16	17 May '63 to 21 June '63 A-21	(659.08) to (666.32)	+7.24
	Electronics		
	- RADVS	(+2.02)	
	Mechanisms		
	- antenna/solar panel positioner 75 ST instead of 6061	(-1.10)	
	Spacecraft vehicle		
	- al. honeycomb foot pads	(+1.14)	
	- wiring harness		
	- vernier solenoid wire size	(+ .60)	
	- ECU shielded twisted pairs	(+3.08)	
	- Coax for TV	(+ .68)	
	- RADVS wire shielding	(+2.06)	
	Main retro		
	- actual weight adjustment - insulation	(+1.10)	

26 August 1963
GV:hr

Basic bus weights -

17	21 June '63 to 26 July '63 A-21	(666.32) to (667.66)	+1.34
	omni antenna boom	(+1.18)	
	act. vs. est. weight--electronics	(+ .48)	
18	21 June '63 to 26 July '63 A-21A	(666.32) to (668.46)	+2.14
	omni antenna boom	(+1.18)	
	act. vs. est. weight--electronics	(+ .48)	
	Comp. A wire severing device	(+ .80)	
19	Anticipated		
	26 July '63 to 26 August '63 A-21	(667.66) to (680.10)	+12.44
	FCSG vibration test fix	(+1.15)	
	RADVS	(+3.29)	
	Battery vibration test fix	(+ .50)	
	Vernier 3-way valve	(2.70)	
	Main retro nozzle	(+2.00)	
	Harness	(+2.00)	
20	Anticipated		
	26 July '63 to 26 August '63 A-21A	(668.46) to (680.80)	+12.34
	FCSG vibration test fix.	(+1.15)	
	RADVS	(+3.29)	
	Battery vibration test fix	(+ .50)	
	Vernier 3-way valve	(+2.70)	
	Comp. B in transit thermal	(+2.70)	
	Main retro nozzle	(+2.00)	

T-2 TEST PROGRAM

Test Vehicle

Modified frame, lunar-g scaled
Vernier engine system
Flight control group (prototype radar and electronics)
Power source
Recovery system (parachute, airbag)

Test objectives

1. Dynamic test of final portion of vernier descent phase including touchdown, near simulation of lunar conditions.
2. Determine ability of vernier engine system and attitude reference system to maintain attitude in dynamic descent.
3. Determine ability of vernier engine system and doppler velocity sensor to align thrust vector.
4. Determine ability of system to attain touchdown conditions.
5. Gather reliability data.

Engine evaluation tests (AFMDC)

Engine system tests (tether tests and static firings)
Problems revealed
Engine and valve redesign

T-2H helicopter tests (Culver City)

RADVS system mounted and flown on helicopter
Improvements indicated

T-2 static and tether tests (AFMDC)

Static firing, 30 July 63: engine performance good

Tether test, 9 August 63: engine performance good, roll oscillation observed

Tether test (scheduled), week of 2 September 63

Drop test preparations

T-2H testing resumed at AFMDC

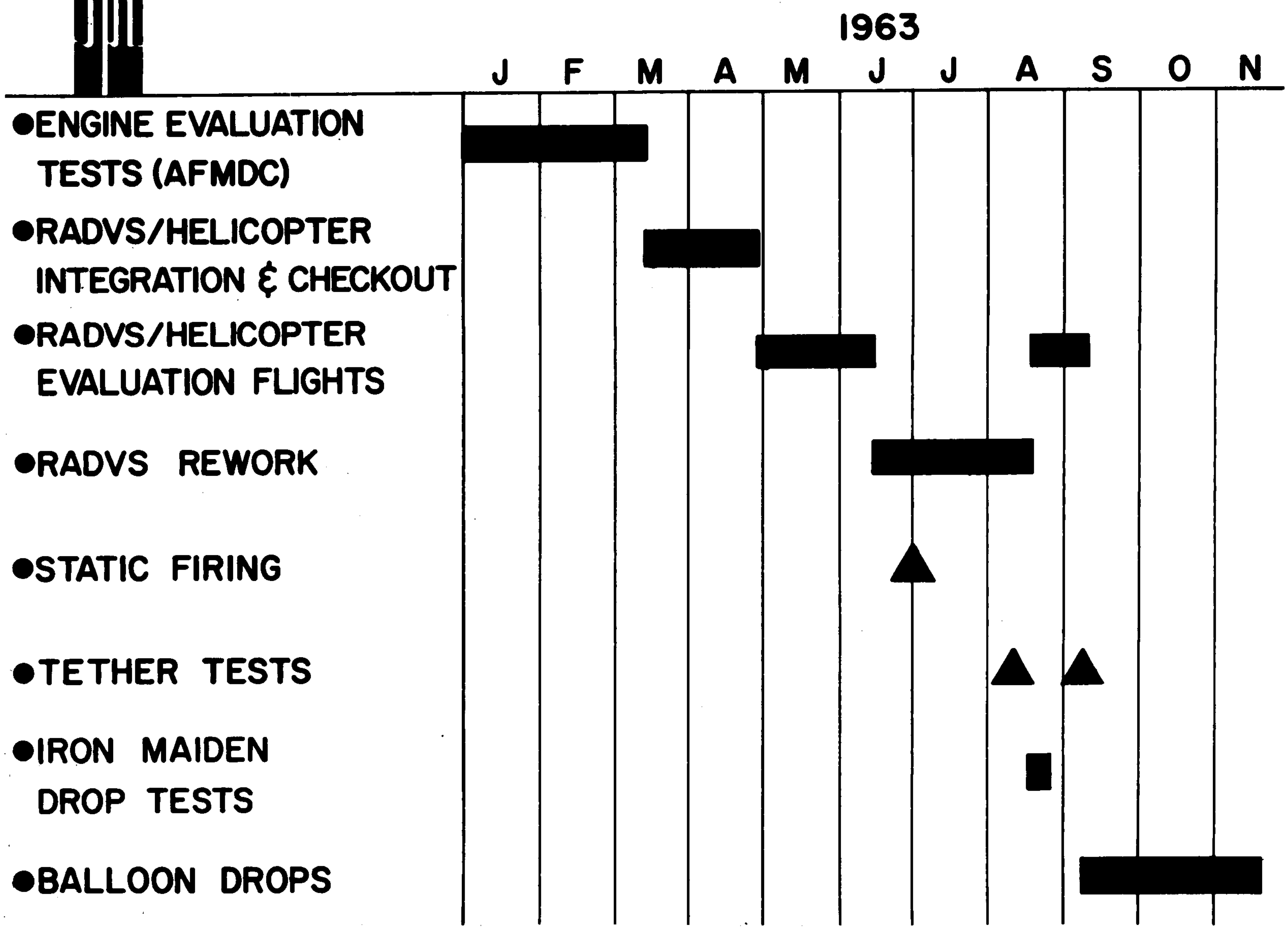
Recovery system test and crew training drop, 21 August

T-2 drops scheduled to begin about 12 September

Drop test plans

Test No.	Objective
1	Radar functional check
2	Radar attitude control (vertical drop)
3	Radar attitude control (non-vertical)
4	Acceleration control
5	Velocity control
6	Trajectory/acceleration loop interaction check
7	Trajectory control (non-vertical)
8, 9	Trajectory control, soft landing

T-2 & T-2H TEST SCHEDULE



T-2 PROBLEM SUMMARY

ITEM		SOLUTION
VERNIER ENGINES		
● THROTTLE VALVE HYSTERESIS	O	NEW THROTTLE VALVE DEVELOPED - SYSTEM TESTING IN PROCESS
● UNSCHEDULED THRUST TRANSIENT	●	LOADING PROCEDURE REVISED
● ROUGH ENGINE RE-START	O	UNDER INVESTIGATION
● HELIUM REGULATOR LOCK-UP FAILURE	O	REDESIGNED REGULATOR - SYSTEM TESTING IN PROCESS
RADVS		
● RODVS* PRESENT PRIOR TO STABLE V_x, V_y, V_z	●	TIME CONSTANT CHANGED
● RANDOM PERTURBATIONS, V_x, V_y, V_z	●	SDC INTERNAL COUPLING CHANGED
● 13 ft MARK UNRELIABLE	O	UNDER INVESTIGATION
● RA KLYSTRON INTERMITTENT	●	DIODE ADDED TO KLYSTRON CONTROL
● KPSM TIME-IN ERRATIC	O	TIMING CIRCUITRY MODIFIED
● SYSTEM TIME CONSTANT LONG	●	CIRCUITRY MODIFIED
● RADAR OUTPUT NOISY	O	UNDER INVESTIGATION
● RANGE QUANTIZATION	O	UNDER INVESTIGATION - APPEARS TO BE NO PROBLEM FOR T-2
● BREAK-LOCK AT GAIN SWITCH	O	UNDER INVESTIGATION
● RODVS* PRESENT AFTER BREAK-LOCK	O	MEMORY TIME REDUCED
● CIRCUIT BOARD FABRICATION SUBSTANDARD	O	REWORK OF BOARDS BY VENDOR
● SDC LOW VOLTAGE POWER SUPPLY UNRELIABLE	O	PRESENT MODULE REWORKED - PARALLEL IN-HOUSE REDESIGN

*RELIABLE OPERATE DOPPLER VELOCITY SENSOR

● = PROBLEM SOLVED

O = FURTHER TESTING NEEDED

T-21 TEST PROGRAM

Functional testing: Class III (prototype) hardware.

- Altitude marking radar
- Central power control
- Television
- Flight control
- RF system
- Central signal processor
- Engineering mechanisms auxiliaries
- Central command decoder

Match/mate testing

- T-21 with Centaur adapter, nose fairing, GSE
- Mechanical and electrical compatibility demonstrated
- Areas of improvement (adapter attachment, GSE design) noted, implemented

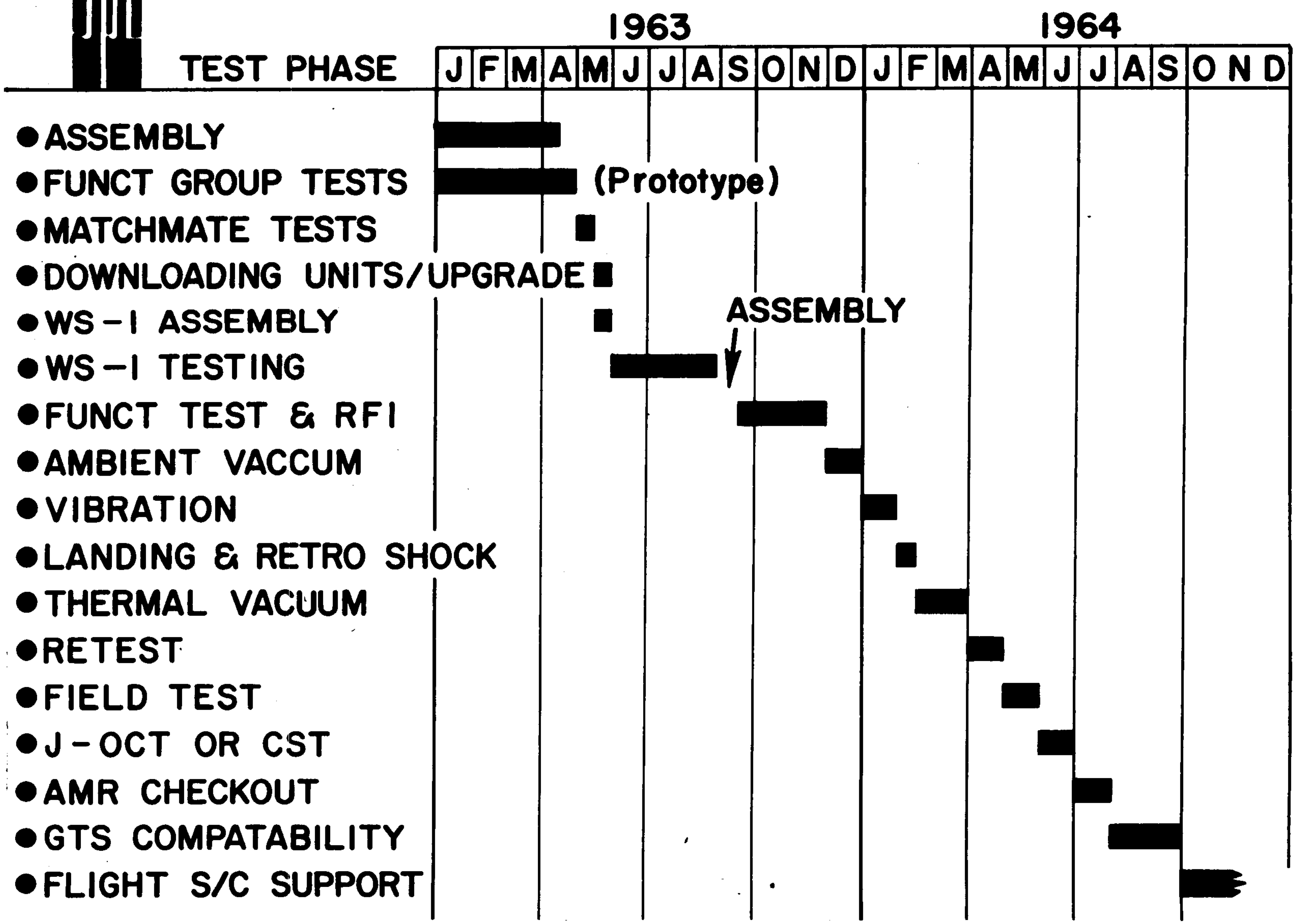
Unit upgrade for TAT

- Some units downloaded for upgrading (spaceframe included)
- Other units replaced

WS-1 ("battleship")

- Welded pipe frame
- Used for continued testing during T-21 frame upgrade
- Interface problems indicated

T-21 SYSTEM TEST SCHEDULE



WS-1 SYSTEM TEST SCHEDULE

JUNE	JULY	AUGUST
GROUP TESTS	**INTEGRATION TESTS**	**INTEGRATION TESTS**
CENTRAL POWER CONTROL	COMMAND DECODER PROCESSOR	RF-COMMAND DECODER
	GROUP TESTS	
RF SYSTEM		TV-TELECOMM.
		GROUP TESTS
SIGNAL PROCESSOR	POWER CONTROL	
FLIGHT CONTROL	RF SYSTEM	TELEVISION
CENTRAL DECODER	FLIGHT CONTROL	

T-21 PROBLEM SUMMARY

Problem	Solution
Command susceptibility	Increase minimum command level
ECU noise	Redesign for decreased noise
AMR overheating	Due to prototype packaging
TV low horizontal resolution	Vidicon alignment
TV auxiliary won't turn off	Revise grounding circuit
TV dark current	Under investigation
Wiring errors	Increased blueprint direction
Canopus indicator blinking	Testing problem only
Grounding	Revise grounding circuits
TV - RF system interaction	Under investigation
Intermittent operations	Under investigation

SURVEYOR

QUALITY ASSURANCE

I. Requirements

II. Program Plan

III. NPC 200-2 Comparative Review

IV. Current Status

I. **REQUIREMENTS**

Applicable Documents:

JPL 30240C	Surveyor Spacecraft System Design Spec.	
		The specification establishes the technical requirements placed upon the contractor in the development and operation of the Spacecraft System.
MIL Q 9858	Quality Control System Requirements	
		This specification requires the establishment of a Quality Control system by the contractor to assure that supplies or services meet the quality standards established by the contract.

Project Management:

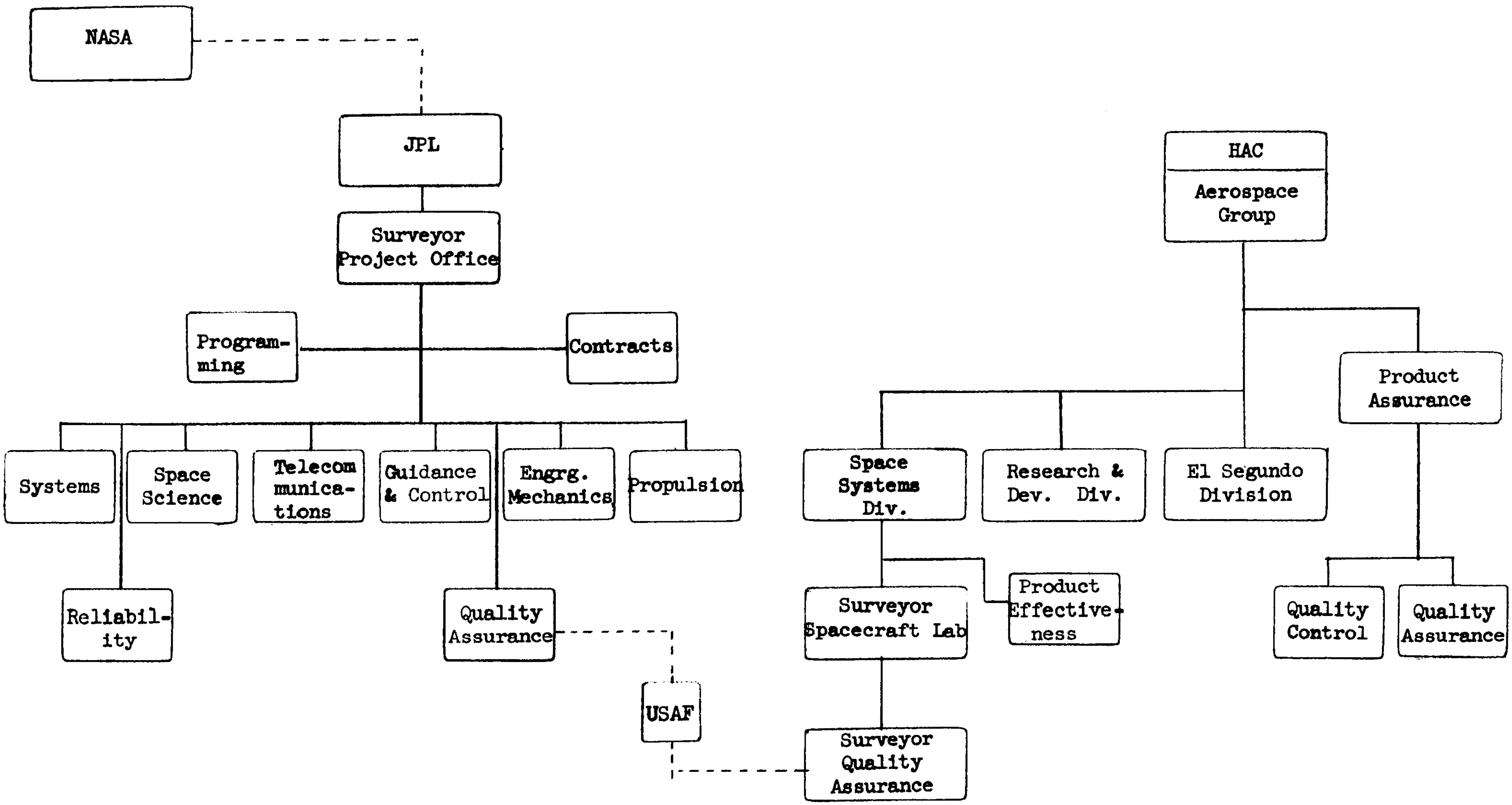
Organization	JPL Surveyor Project Office HAC Surveyor Spacecraft Laboratory
Personnel & Staffing	JPL - AFPR HAC QA, QC

Project Quality Plan:

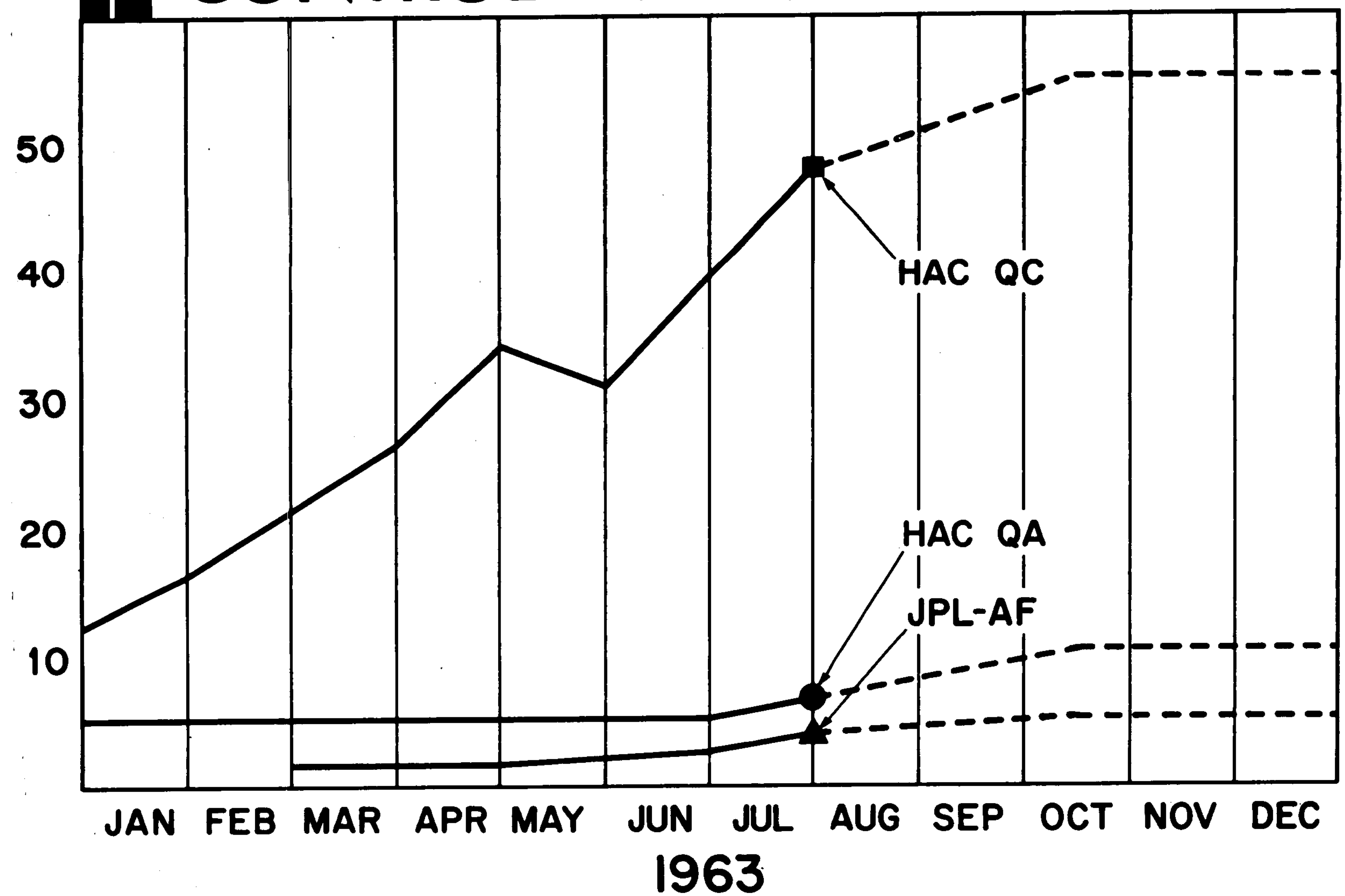
Broad Objectives — Protect the inherent equipment reliability by minimizing the possibility of errors in:

- Procurement
- Fabrication
- Assembly
- Test
- Spacecraft Launch

JPL-HAC ORGANIZATION CHART



QUALITY ASSURANCE & CONTROL MANPOWER



II. PROGRAM PLAN

Planning

Major Areas	Prefabrication Fabrication and Assembly Test Shipping and Field Assurance
Procedures	Quality Assurance Guidelines to satisfy Surveyor requirements and contractual commitments. Receipt, identification, stocking, and issuing of materials. Fabrication and assembly operations. Application of statistical sampling. Product packaging, shipping, storage and maintenance. Non-conforming supplies.
Manufacturing Plan	Inspection flow charts. Inspection instructions.
Quality Standards	Workmanship standards. Shop standards. Supplier provisions.
Milestone Schedule	Quality Assurance Tasks

Implementation

Design Review	Assure that characteristics pertinent to product quality are considered and appropriately monitored.
Method Review	Assure that the methods and procedures utilized specifically delineate the manufacturing processes in a repeatable manner which will preserve the inherent design.
Drawing Change Control	Released through control point.
Component Parts Program	Qualified parts Qualification Selected suppliers Acceptance criteria
Procurement Spec Review	Quality Assurance provision. Parts identification Acceptance testing Material handling Source inspection requirements
Quality Capability of Vendors	Approved vendor list Facility survey Approve Quality systems Rating systems
Purchase Requisition Screening	Defines Quality requirements Inspection levels Routing
Surveillance of Vendors	To assure that Quality is consistent with requirements. In process inspection Final inspection Monitoring of calibration schedules Review manufacturing techniques and process controls Documentation of Quality levels Observance of testing Failure Reports & Analysis, MRB
Receiving Inspection	To assure conformance with the requirements of the purchase orders.
Inspection Stamps	Evidence of the inspection status of materials, processes, parts and assemblies.

Manufacturing Control	Process flow charts Assembly instruction In process inspection requirements Inspection stations Performance documentation
Test Surveillance	Test specification & procedures
Calibration of Instruments	Timely certification of measuring and test equipment traceable to NBS

III COMPARATIVE REVIEW

HAC Quality Assurance Plan and Implimentation
as Compared to NASA NPC 200-2 Requirements

Item	NPC 200-2	HAC Q.A. Plan	Compliance Code: A = satisfies B = marginal C = upgrading D = not in plan
Basic Requirement			
Quality Program	2.1	1.1	A
Quality Program Documentation	2.2	2.2.1	A
Management			
Planning	3.1	1.0	A
Organization	3.2	2.1	A
Design & Development Control			
Design Review	4.1	2.3	A
Drawing & Spec. Review	4.2	3.0	B
Qualification Tests	4.3	3.1	B
Identification	4.4	3.5	B
Control of Contractor Procured Material			
Adequacy & Quality	5.1	4.0	A
Selection of Procurement Source	5.2	4.1	A
Procurement Documents	5.3	4.2	A
Government Source Inspection	5.4	4.4.3	C
Contractor Source Inspection	5.5	4.4.4	B
Receiving Inspection	5.6	4.4.7	A
Identification	5.7	4.4.7	B
Failure & Deficiency Feedback	5.8	4.4.1	B
Supplier Rating & Preferred Parts List	5.9	4.1	A
Coordination of Contractor--Supplier Measuring & Test Equipment	5.10	5.7	B
Control of Government Furnished Property (GFP)			
Inspection of GFP	6.1	-	D
Defective GFP	6.2	-	D

Item	NPC 200-2	HAC Q.A. Plan	Compliance Code
Control of Contractor Fabricated Articles			
Conformance Criteria	7.2	5.4	B
Inspection & Test Planning	7.3	5.6	B
Inspection & Test Performance	7.4	5.5	B
Fabrication Control	7.5	5.2	B
Nonconforming Material			
Material Review	8.1	2.6	A
Approval of Contracting Officer	8.2	2.6	A
Control of Nonconforming Material	8.3	2.6	A
Rework without MRB	8.4	2.6	A
Inspection, Measuring and Test Equipment			
Calibration	9.2	5.7	A
Calibration Facilities and Standards	9.3	5.7	A
Evaluation	9.4	5.7	B
Maintenance & Control	9.5	5.7	A
Written Procedures	9.6	5.7	C
Records	9.7	5.7	C
Inspection Stamps			
Maintain Stamp Control	10.1	5.6	A
Preservation, Packing, Handling Storage & Shipping			
Written Procedures	11.1	6.1	A
Preservation	11.2	6.1	A
Packaging	11.3	6.1	A
Handling	11.4	2.5	A
Storage	11.5	2.5	A
Shipping	11.6	6.1	A

jpl RELIABILITY PROGRAM: Phase I

ACTIVITY	% COMPLETE
• PREPARE SYSTEM RELIABILITY BLOCK DIAGRAM	100
• DEVELOP MATH MODELS	100
• CONDUCT REDUNDANCY OPTIMIZATION STUDIES	90
• PARTICIPATE IN PRELIMINARY DESIGN REVIEWS	95

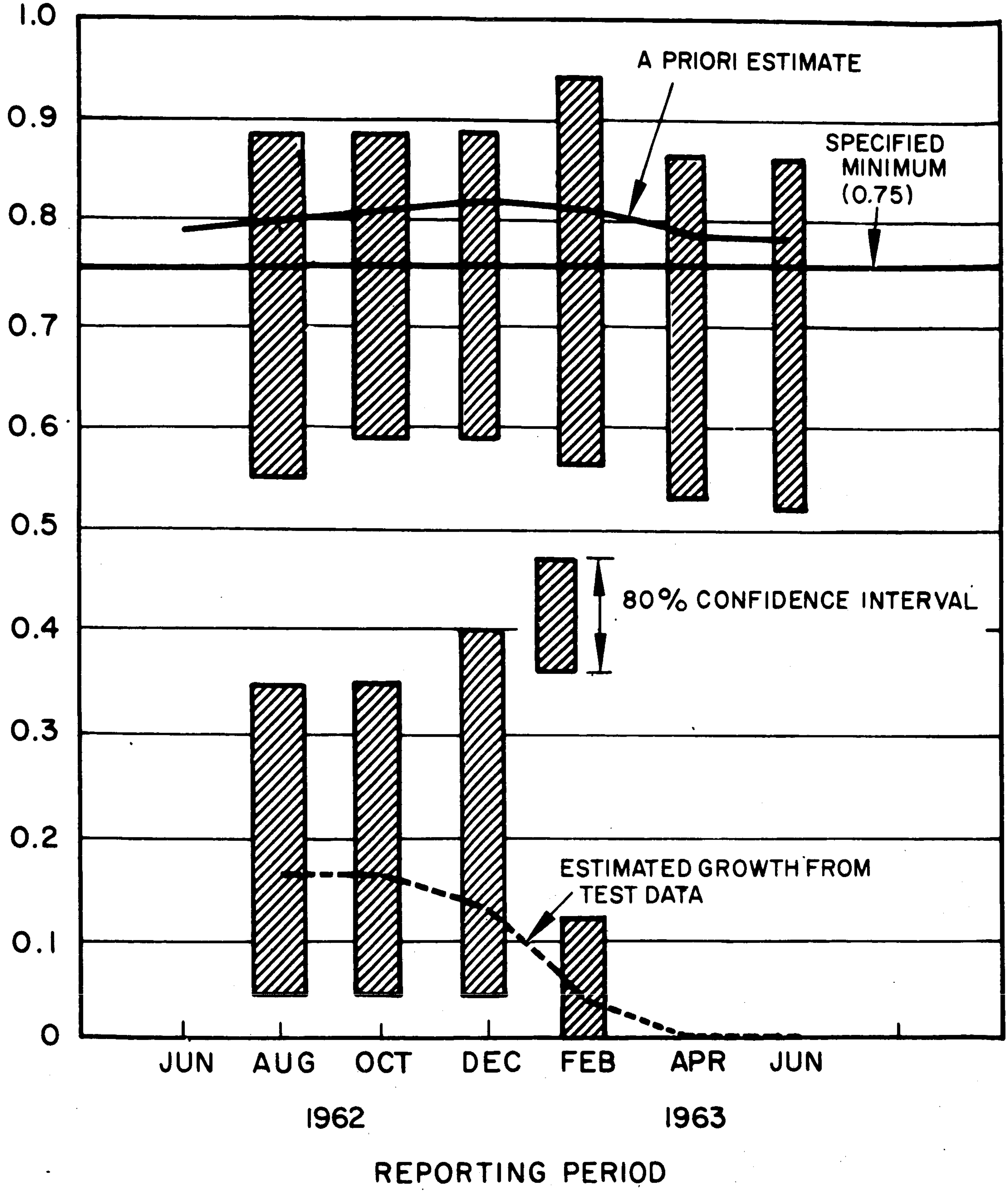
RELIABILITY PROGRAM: Phase II,

DETAILED RELIABILITY DESIGN

ACTIVITY	% COMPLETE
• DEVELOP RELIABILITY PROGRAM PLAN	100
• REFINE RELIABILITY MODELS	(CONTINUOUS)
• ESTABLISH RELIABILITY PREDICTION SYSTEM	(CONTINUOUS)
• PARTICIPATE IN DESIGN & CHANGE REVIEWS	(CONTINUOUS)
• PERFORM FAILURE AUDITS	80
• ESTABLISH COMPONENT SELECTION & QUALIFICATION PROGRAM	90
• ESTABLISH MATERIAL & PROCESS REQUIREMENTS	95
• PREPARE RELIABILITY ASSURANCE TEST PLAN	90
• CONDUCT SUBCONTRACT LIAISON	(CONTINUOUS)
• CONDUCT TRAINING & MOTIVATION LECTURES	20

RELIABILITY PROGRAM: Phase III, FABRICATION, TEST, & OPERATIONS

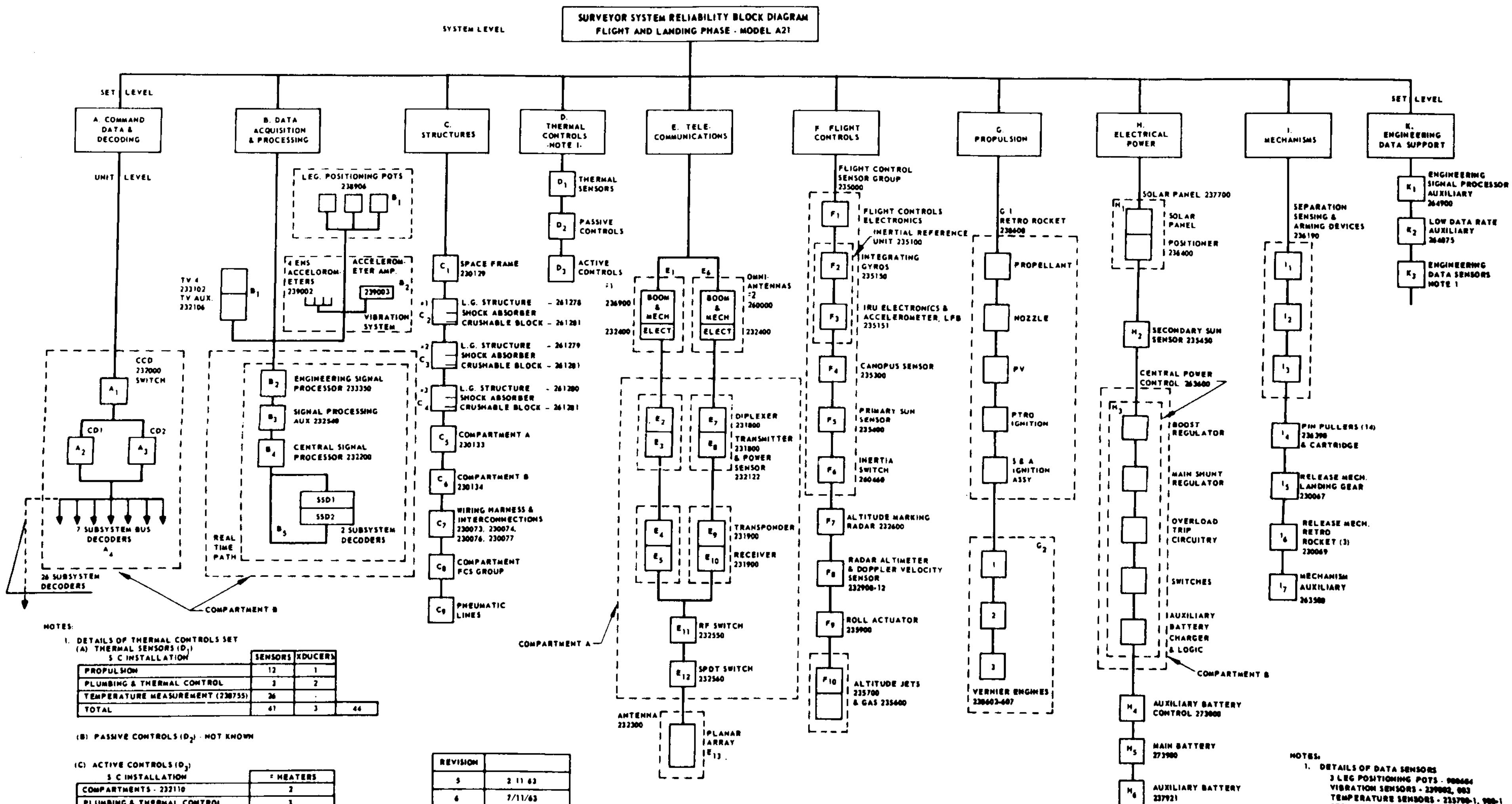
ACTIVITY	% COMPLETE
● CONTINUE REFINEMENT OF RELIABILITY ANALYSIS	(CONTINUOUS)
● IMPLEMENT FAILURE REPORTING, DIAGNOSIS AND REVIEW	(CONTINUOUS)
● CONDUCT RELIABILITY ASSURANCE TEST PROGRAM	0
● MAINTAIN SUBCONTRACTOR LIAISON	(CONTINUOUS)
● PARTICIPATE IN ALL SYSTEM TESTING	(CONTINUOUS)
● CONTINUE TRAINING AND MOTIVATION PROGRAM	0
● REVIEW AND APPROVE SPECIFICATION AND DESIGN CHANCES	(CONTINUOUS)



Reliability growth for flight and landing

	SET NOMENCLATURE		RELIABILITY EQUATION	CONSTRAINTS & SPECIAL CONDITIONS
	SYMBOL	NAME		
FLIGHT & LANDING PHASE	A	COMMAND DATA & DECODING	(1) $R_A = A_1 A (2-A) A_4^7$ $A_1 = A_2 = A$	USES SWITCH (A_1) IN SERIES WITH 2 REDUNDANT DECODERS (A_2, A_3).
	B	DATA PROCESSING	(2) $R_B = B_1 B_2 B_3 B_4 B_5$	B_2, B_3, B_4 ARE PROCESSING EQUIPMENT. ALL UNITS ARE IN SERIES.
	C	STRUCTURES	(3) $R_C = C_1 C_2 C_3 C_4 C_5 C_6 C_7 C_8 C_9$	UNITS ARE ASSUMED TO BE IN SERIES.
	D	THERMAL CONTROLS	(4) $R_D = D_1 D_2 D_3$	REDUNDENCIES WITHIN BUT NOT BETWEEN D_1, D_2 AND D_3.
	E	TELECOMMUNICATIONS	(5) $R_E = a^2 b^2 c^2 d^2 e^2 E_{11} E_{12} \left(\frac{2}{a} \cdot \frac{2}{b} \cdot \frac{2}{c} \cdot \frac{2}{d} \cdot \frac{2}{e} - 9\right)$ $E_1 = E_6 = a$, $E_2 = E_7 = b$, $E_3 = E_8 = c$, $E_4 = E_9 = d$, $E_5 = E_{10} = e$	HIGH ORDER TERMS AMONG a, b, c, d, e ARE CONSIDERED NEGLIGIBLE.
	F	FLIGHT CONTROLS	(6) $R_F = F_1 F_2 F_3 F_4 F_5 F_6 F_7 F_8 F_9 F_{10}$	UNITS ARE CONSIDERED TO BE IN SERIES.
	G	PROPULSION	(7) $R_G = G_1 G_2$	BOTH RETRO AND VERNIER ENGINES ARE CONSIDERED TO BE IN SERIES.
	H	ELECTRIC POWER	(8) $R_H = H_1 H_2 H_3 H_4 (H_{5_a} + H_{6_a} - H_{5_a} H_{6_a})(H_{5_b} + H_{6_b} - H_{5_b} H_{6_b})$	H_{5_a}, H_{6_a} = PROB THAT MAIN BTRY AND AUX BTRY DO NOT FAIL CATASTROPHICALLY RESPECTIVELY H_{5_b} = PROB THAT MAIN BTRY STORES SUFFICIENT PWR TO SUPPLY ALL ESSENTIAL POWER AT ALL TIMES H_{6_b} = PROB THAT AUX BTRY STORES SUFFICIENT PWR TO SUPPORT MAIN BTRY WHEN NEEDED.
	I	MECHANISMS	(9) $R_I = I_1 I_2 I_3 I_4 I_5 I_6 I_7$	UNITS ARE CONSIDERED TO BE IN SERIES.
	K	ENGINEERING DATA SUPPORT	(10)	
LUNAR PHASES	A	COMMAND DATA & DECODING	(11) $R_A = A_1 A (2-A)$ $A_2 = A_3 = A$	SIMILAR TO ABOVE EXCEPT THAT THE SEVEN BASIC BUS SUBSYSTEM DECODERS, A_4, ARE NOT USED.
	B	DATA PROCESSING	(12) $R_B = B_2 \; B_3 \; B_4 \; B_5$	SIMILAR TO ABOVE EXCEPT THAT TV #4, B_1, IS NOT NEEDED
	C	STRUCTURES	(13) $R_C = C_1 C_5 C_6 C_7$	BASIC STRUCTURE C_1, WIRING HARNESS C_7, AND COMPARTMENTS C_5 AND C_6 ARE ASSUMED TO BE IN SERIES.
	D	THERMAL CONTROLS	(14) $R_D = D_1 D_2 D_3$	SIMILAR TO ABOVE.
	E	TELECOMMUNICATIONS	(15) $R_E = a^2 b^2 c^2 e^2 E_{11} E_{12} E_{13} \left(\frac{2}{a} + \frac{2}{b} + \frac{2}{c} + \frac{2}{e} - 7\right)$	SIMILAR TO ABOVE EXCEPT THAT TRANSPOND MODE IS NOT NEEDED. SYMBOLS ARE DEFINED AS ABOVE. PLANAR ARRAY, E_B, MUST NOT FAIL.
	H	ELECTRIC POWER	(16) $R_H = H_1 H_2 H_3 H_4 (H_{5_a} + H_{6_a} - H_{5_a} H_{6_a})(H_{5_b} + H_{6_b} - H_{5_b} H_{6_b})$	SIMILAR TO ABOVE, SYMBOLS DEFINED AS ABOVE
	J	SCIENTIFIC INSTRUMENT SUPPORT	(17) $R_J = (J_1 J_2 J_3 J_4 J_5 J_6 J_7 J_8) \left(\frac{1}{J_1} + \frac{1}{J_2} + \frac{1}{J_3} + \frac{1}{J_7} + \frac{1}{J_8} - 4\right)$	J_4, J_5, AND J_6 MUST NOT FAIL AND ONE AND ONLY ONE OF J_1, J_2, J_3, J_7, J_8 IS PERMITTED TO FAIL IF SET IS TO BE CONSIDERED A SUCCESS.
			SYSTEM EQUATIONS: (18) F AND L = $R_{S_F} = R_A R_B R_C R_D R_E R_F R_G R_H R_I R_K$ (19) LUNAR PHASES = $R_{S_L} = R_A R_B R_C R_D R_E R_H R_J$ (20) MISSION = $R_M = R_{S_F} R_{S_L}$	USES R's FOR F AND L ONLY USES R's FOR LUNAR PHASES ONLY

REVISED: 7-12-63



NOTES:

1. DETAILS OF THERMAL CONTROLS SET

(A) THERMAL SENSORS (D_1)

S C INSTALLATION	SENSORS	XDUCERS	
PROPULSION	12	1	
PLUMBING & THERMAL CONTROL	3	2	
TEMPERATURE MEASUREMENT (230755)	26	-	
TOTAL	41	3	44

(B) PASSIVE CONTROLS (D_2) - NOT KNOWN

(C) ACTIVE CONTROLS (D_3)

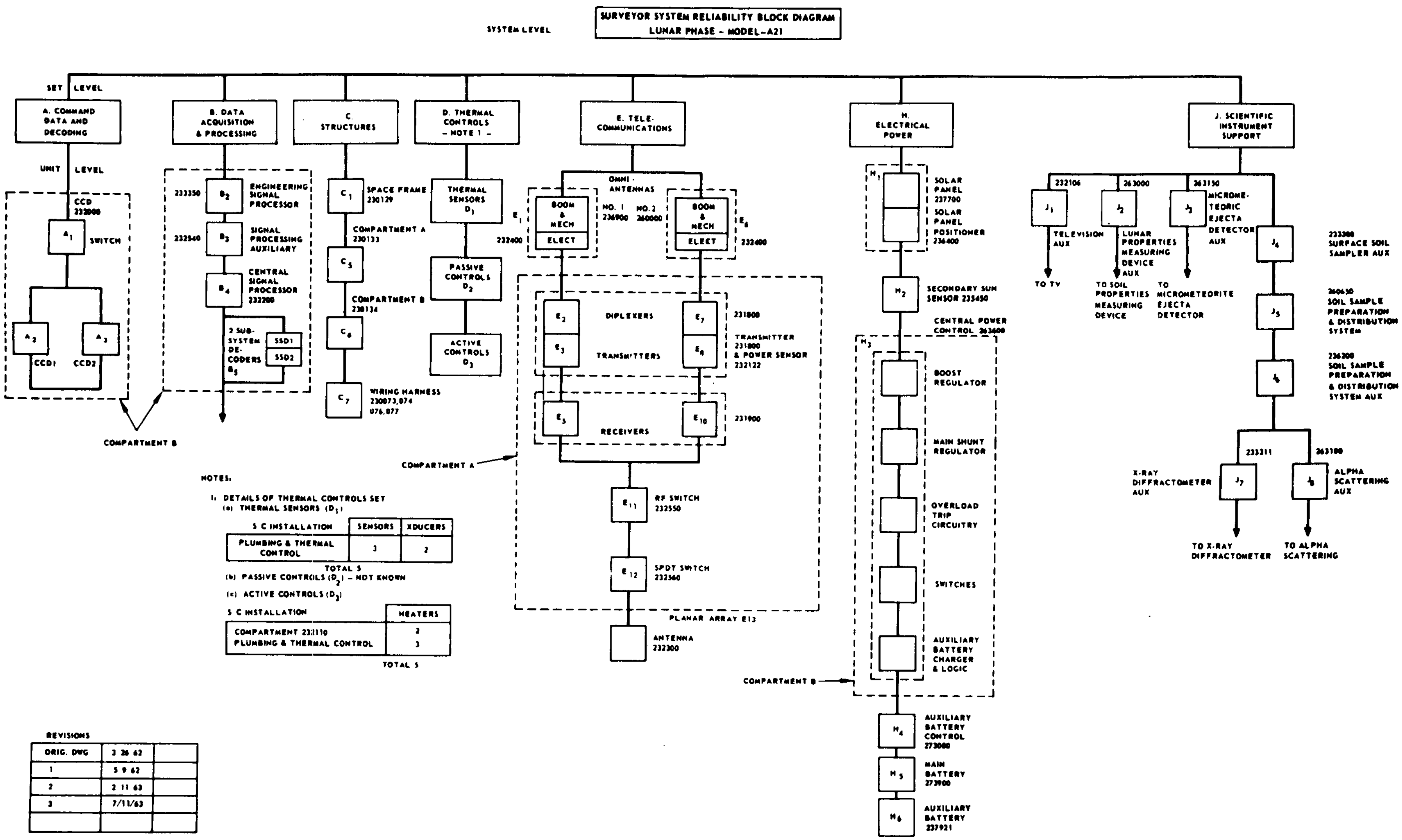
S C INSTALLATION	# HEATERS
COMPARTMENTS - 232110	2
PLUMBING & THERMAL CONTROL	3
TOTAL	5

REVISION	
5	2 11 63
6	7/11/63

NOTES:

1. DETAILS OF DATA SENSORS
   - 3 LEG POSITIONING POTS - [illegible]
   - VIBRATION SENSORS - 239002, 003
   - TEMPERATURE SENSORS - 235700-1, 900-1
   - STRAIN GAUGES
   - BATTERY PRESSURE SENSORS
   - OTHER ENGINEERING SENSORS

-15-



NOTES:

1. DETAILS OF THERMAL CONTROLS SET
   (a) THERMAL SENSORS (D_1)

S C INSTALLATION	SENSORS	XDUCERS
PLUMBING & THERMAL CONTROL	3	2

TOTAL 5

   (b) PASSIVE CONTROLS (D_2) - NOT KNOWN
   (c) ACTIVE CONTROLS (D_3)

S C INSTALLATION	HEATERS
COMPARTMENT 232110	2
PLUMBING & THERMAL CONTROL	3

TOTAL 5

REVISIONS

ORIG. DWG	3 26 62	
1	5 9 62	
2	2 11 63	
3	7/11/63	

X = 224602 REQUIREMENT INTACT
S = SATISFACTORY
U = UNSATISFACTORY
BLANK = NOT REQUIRED

MOD. = MODIFIED
N/A = NOT APPLICABLE
CLOSED = CONTRACT COMPLETE
NR = NO RESPONSE TO THIS REQUIREMENT NOW

COMPARISON OF SUBCONTRACTOR COMPLIANCE TO WORK STATEMENTS & HAC RELIAB. SPEC. MIN. REQUIREMENTS

CHANGED U,S

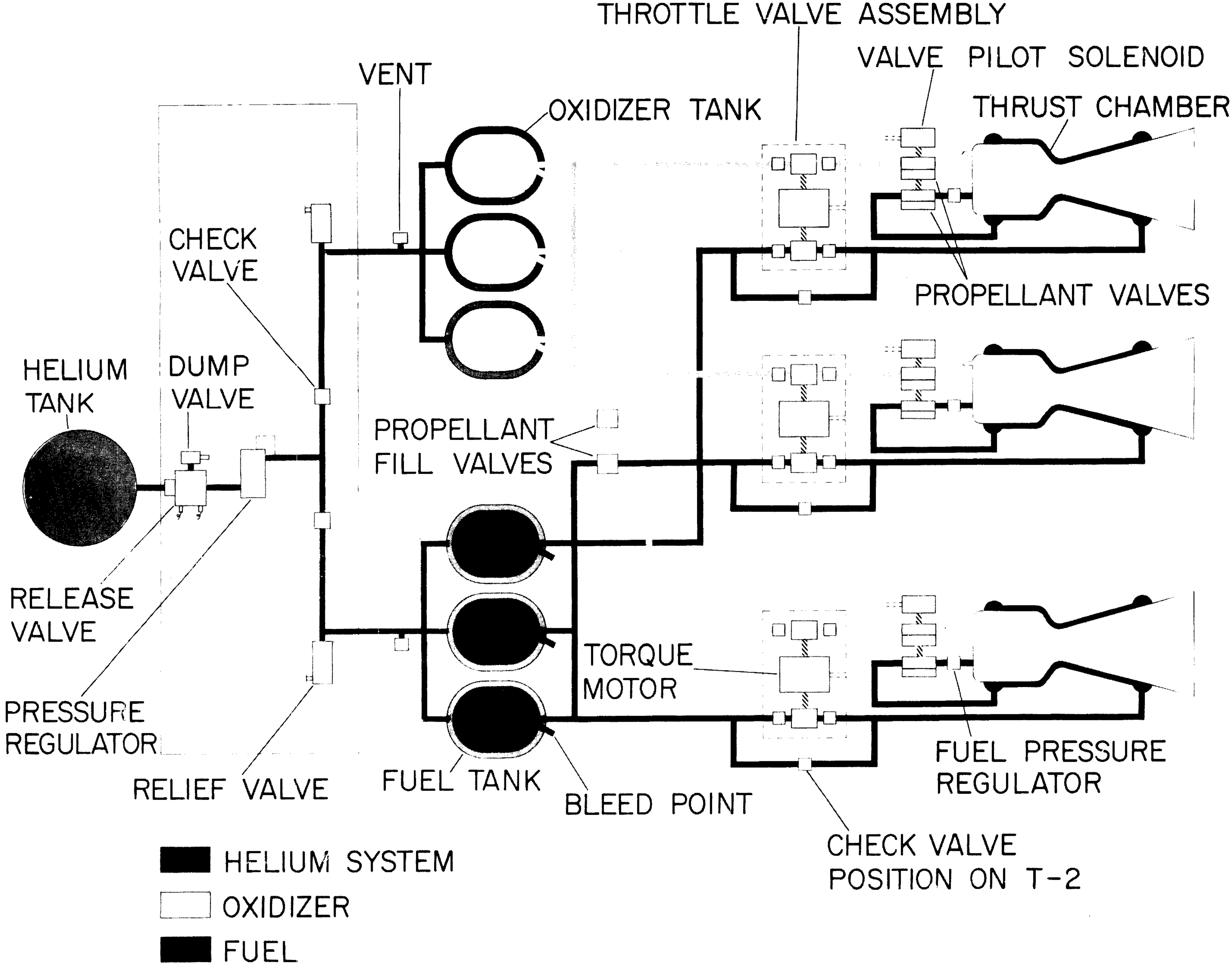
ORIG. 15 MARCH 1963
REV. A: 1 AUGUST 1963

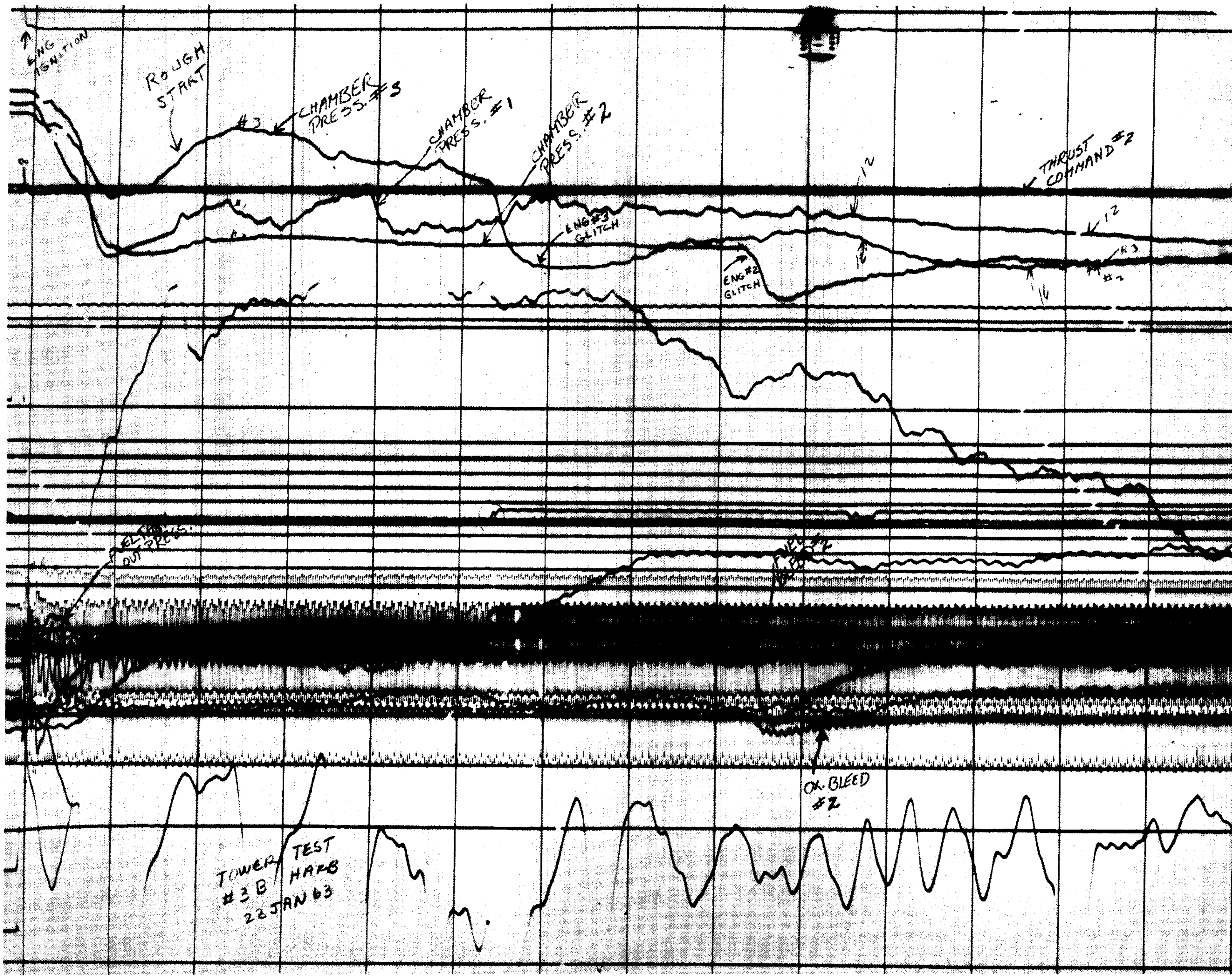
*V.L. LENS REDESIGN
**FOLLOW-ON ORDER

224601 MAJ. REQ.	(RADVS) RYAN		(RETRO) THIOKOL ELKTON		(VERNIER) THIOKOL RMD		(SHOCK) ABSORB NAT. WATER LIFT		(BATTERY) ELECTRIC STORAGE BATTERY		(SOLAR) CELLS HELIOTEK		(GYROS) KEARFOTT		(R F MAG.) ASSY METCOM	
PAR. DESCRIPTION	WORK STAT.	COM-PLIANCE	WORK STAT.	COM-PLIANCE	WORK STAT.	COM-PLIANCE	WORK STAT.	COM-PLIANCE	WORK STAT.	COM-PLIANCE	WORK STAT.	COM-PLIANCE	WORK STAT.	COM-PLIANCE	WORK STAT.	COM-PLIANCE
2.1 MIL STD 441								S					X	S		
3.1.1 ACHIEVE & VERIFY RELIAB.	X	U	X	S-	MOD.	U C	X	S	X	NR U	X	U	X	S U	X	S U
3.1.2 PROGRAM PLAN	X	S	MOD.	S-	X	S U	X	S	X	NR C	X	S	X	S-	X	S
3.1.3 DOCUMENT OF PROGRESS	X	S	X	S-	X	C	X	S	X	NR S-	X	U	X	S U	X	S U
3.1.4 APPROV. NON STD. PARTS		S	X	S			X	S	X	S			X	S	X	NA U
3.1.6 PASSING ON RELIAB. REQ. TO VENDORS			X	S U	X	S U	N/A	N/A	X	U	X	U	X	S U	X	S U
3.2.1 TO 3 PRED. - DESIGN	X	S	X	S	X	U	X	S	X	S U	X	S	X	S U	X	S
3.2.2.1 TO 3 PRED. TEST DATA	X	U	MOD.	S-	X	NR	X	S	X	NR C	X	U	X	S U	X	S U
3.2.3 FAILURE REPORT & ANAL.	X	S U	X	S	X	S U	X	S	X	S	X	U	X	S	X	S
3.2.5 CRITICAL PARTS CONTROL	X	S	X	S U	X	S U	X	S	X	S	X	S	X	S-	X	N/A
3.2.6 FABRICATION CONTROL	X	S	MOD.	S U	MOD.	S U	X	S	X	S U	X	S	X	S	X	S
3.2.7.8 REPORTS	X		MOD.	S-	MOD.	S U	X	S	X	S-	X	U	X	S U	X	S
3.3 SUPPORTING EFFORTS	X	S	X	S-	MOD.	S U	X	S	X	S U	X	S-	X	S	X	S U
4.? MINIMUM VERIF.	X	U	X	S-	X	U	X	S			X	U	X	S	X	S U
4.3 VERIFICATION BY TEST									X	S-						

224601 MAJ. REQ.	MAGNETRON MOD. MAGNETIC RESEARCH		F.L. LENS BELL & HOWELL		V.L. LENS * BELL & HOWELL		SQUIBS ORD. ASSOC.		ACCEL. & AMPL ENDEVCO		CANOPUS SENSOR HAC SBRC		MICROWAVE MIXER VARIAN		SEPARATION DEV. BEING SELECTED		VCO VECTOR **	
PAR. DESCRIPTION	WORK STAT.	COM-PLIANCE	WORK STAT.	COM-PLIANCE	WORK STAT.	COM-PLIANCE	WORK STAT.	COM-PLIANCE	WORK STAT.	COM-PLIANCE	WORK STAT.	COM-PLIANCE	WORK STAT.	COM-PLIANCE	WORK STAT.	COM-PLIANCE	WORK STAT.	COM-PLIANCE
2.1 MIL STD 441		U							X	S								
3.1.1 ACHIEVE & VERIFY RELIAB.	X	U	X	U S	X	U S	X	S	X	U S	X	S			X		X	U
3.1.2 PROGRAM PLAN	X	S	X	S U	X	S-	X	S	X	S	X	S			X		X	S
3.1.3 DOCUMENT OF PROGRESS	X	S	X	S U	X	S-	X	S	X	S	X	S			X		X	S
3.1.4 APPROV. NON STD. PARTS	X	S	X	S	X	S	X	S	X	S	X	S			X		X	U
3.1.6 PASSING ON RELIAB. REQ. TO VENDORS	X	U	X	N/A	X	N/A	N/A	N/A	X	S	X	S			X		X	S
3.2.1 TO 3 PRED. - DESIGN	X	S	X	U	X	S	X	S	X	S	X	S			X	VENDOR BEING SELECTED	X	S
3.2.2.1 TO 3 PRED. TEST DATA	X	U	X	U	X	U S-	X	S	X	S	X	NR S	CLOSED	CLOSED	X		X	U
3.2.3 FAILURE REPORT & ANAL.	X	S	X	U S	X	U S-	X	S	X	S	X	U S-			X		X	U
3.2.5 CRITICAL PARTS CONTROL	X	S U	X	S U	X	S	X	S	X	S	X	S			X		X	S
3.2.6 FABRICATION CONTROL	X	S U	X	S U	X	S	X	S	X	S	X	S U			X		X	S
3.2.7.8 REPORTS	X	S	X	S	X	S	X	S	X	S	X	S			X			
3.3 SUPPORTING EFFORTS	X	S U	X	S	X	S	X	S	X	S	X	S			X		X	U
4.? MINIMUM VERIF.	X	U	X	U	X	U S-			X	S							X	U
4.3 VERIFICATION BY TEST							X	S	X	U S	X	S			X			

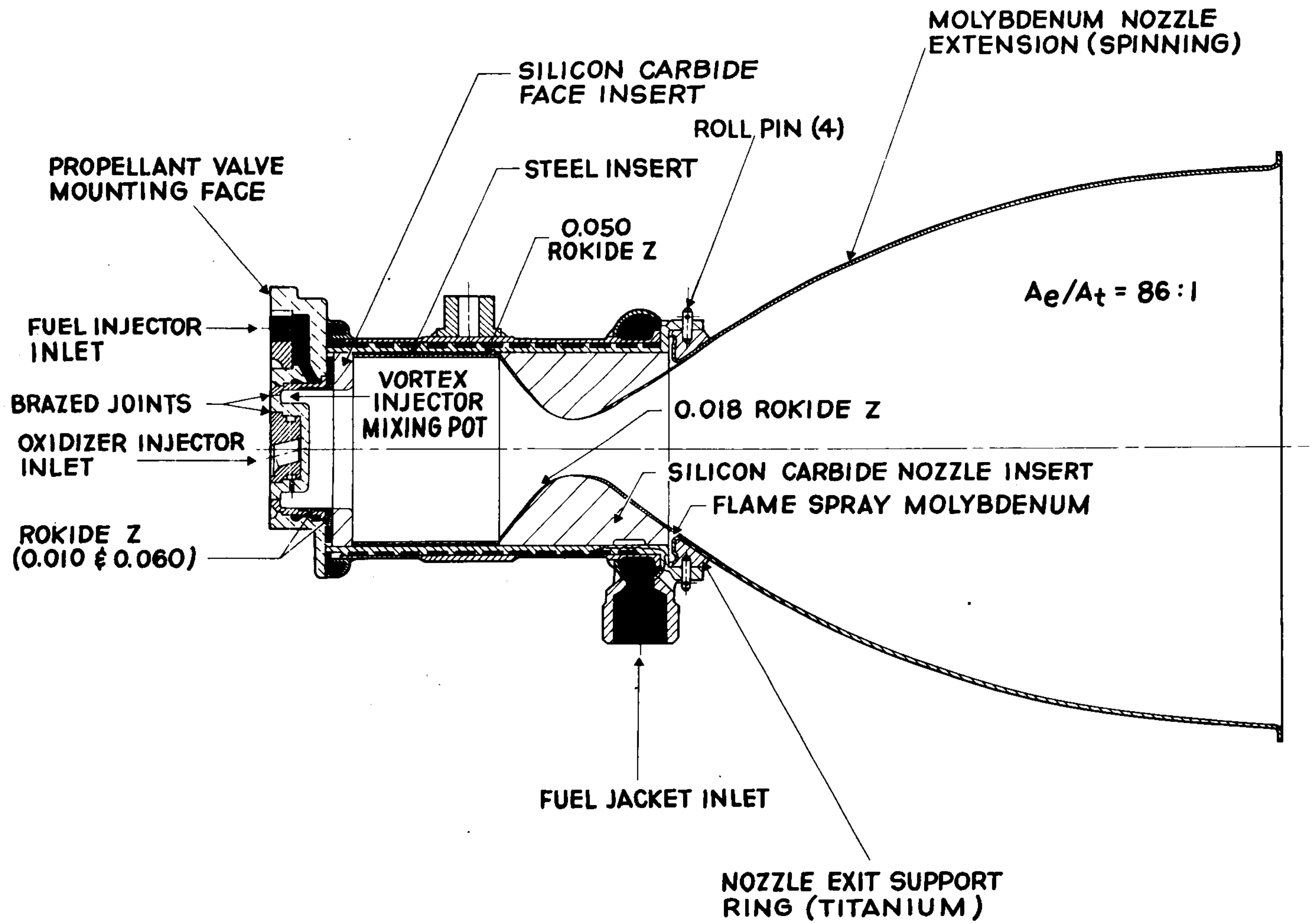
VERNIER PROPULSION SYSTEM SCHEMATIC

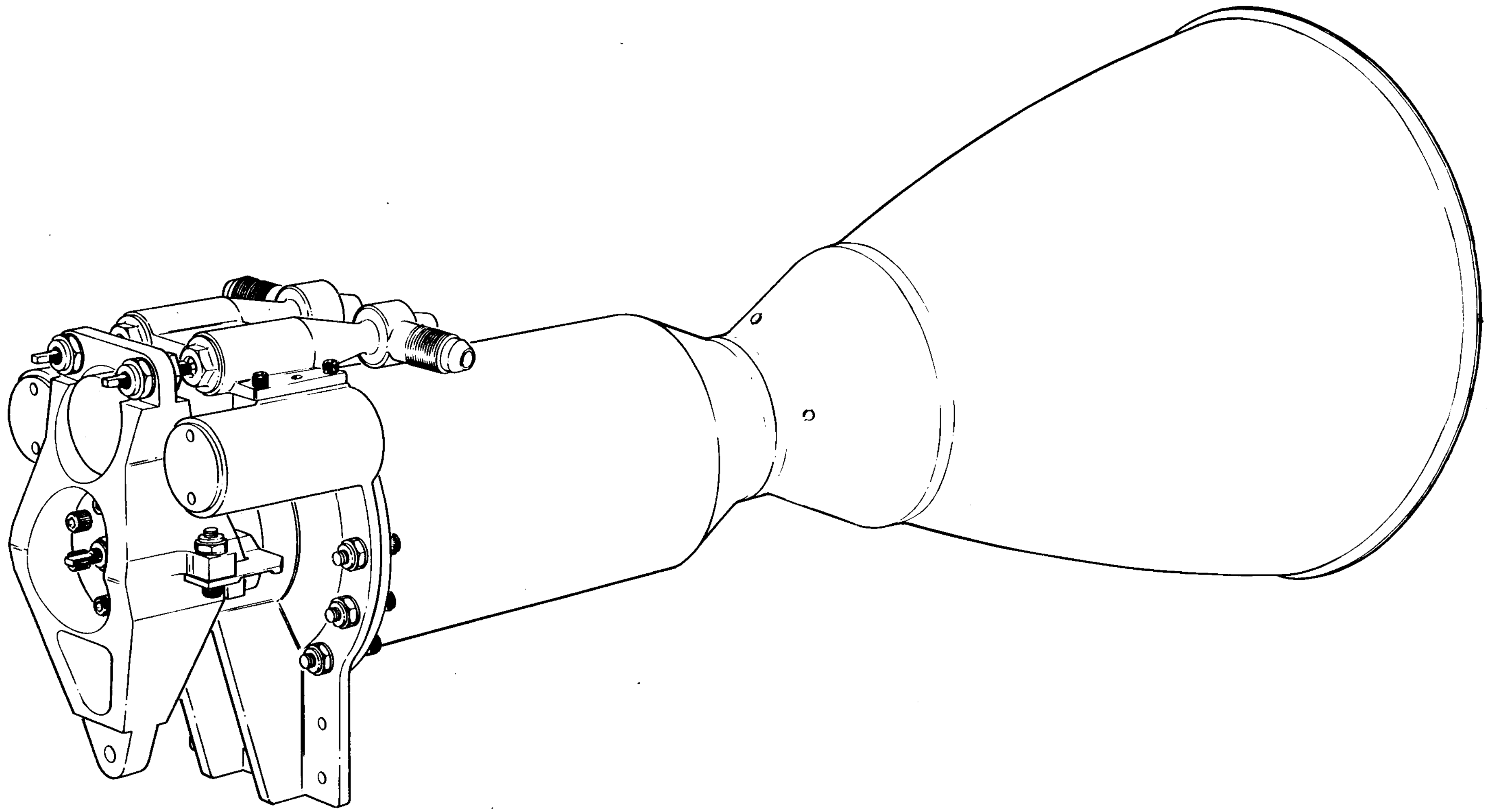




Tower Test No. 3B -- Rough Start and "Glitch"

TD-280 THRUST CHAMBER





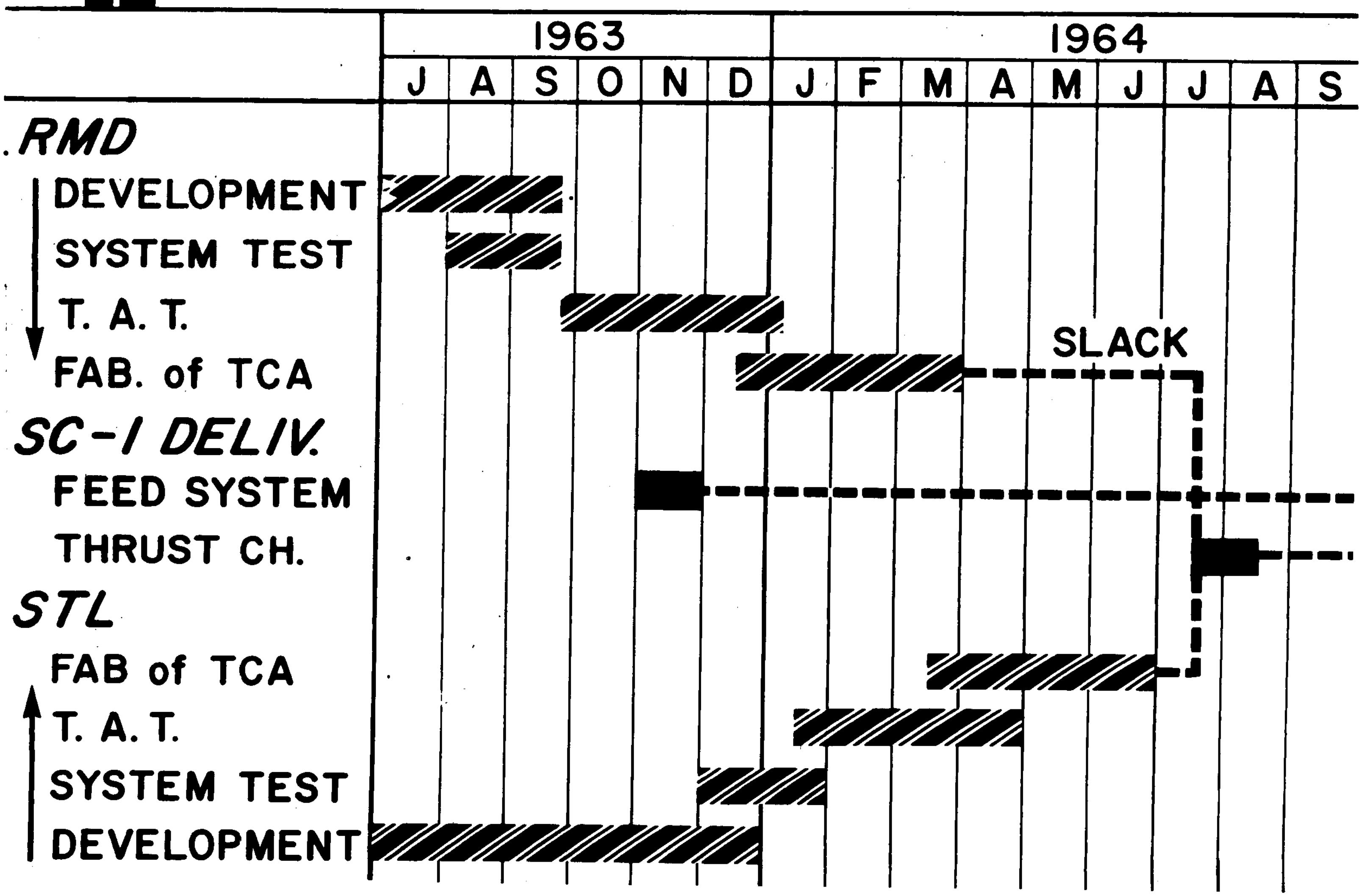
VERNIER ENGINE BACKUP THRUST CHAMBER ASSEMBLY

VERNIER TCA COMPARISON

	RMD	STL	
	21 SEP	1 AUG	1 JAN
THRUST, lb.			
MAXIMUM	104	150	180
MINIMUM	30	30	20
THROTTLE RANGE	3.2:1	5:1	9:1
WEIGHTED I_{sp}, sec.	287	289	296
TCA MASS, lb.	7.3	9.5	9.5
Δ PAYLOAD, lb.	−8.5	−12.6*	+8.6

* Due to Use of Original Flight Control Logic

VERNIER PROPULSION SYSTEM SCHEDULE



ADVANTAGES of 1 JAN DESIGN BACKUP CHAMBER

- LOWER IGNITION ALTITUDE
- HIGHER TORQUE CAPABILITY
- UNCHANGED RELIABILITY GOAL
- INCREASED VERNIER FUEL CAPABILITY
- REDUCED POWER DRAIN
- GREATER SPACECRAFT INTEGRATION FLEXIBILITY
- GREATER DEVELOPMENT LATITUDE

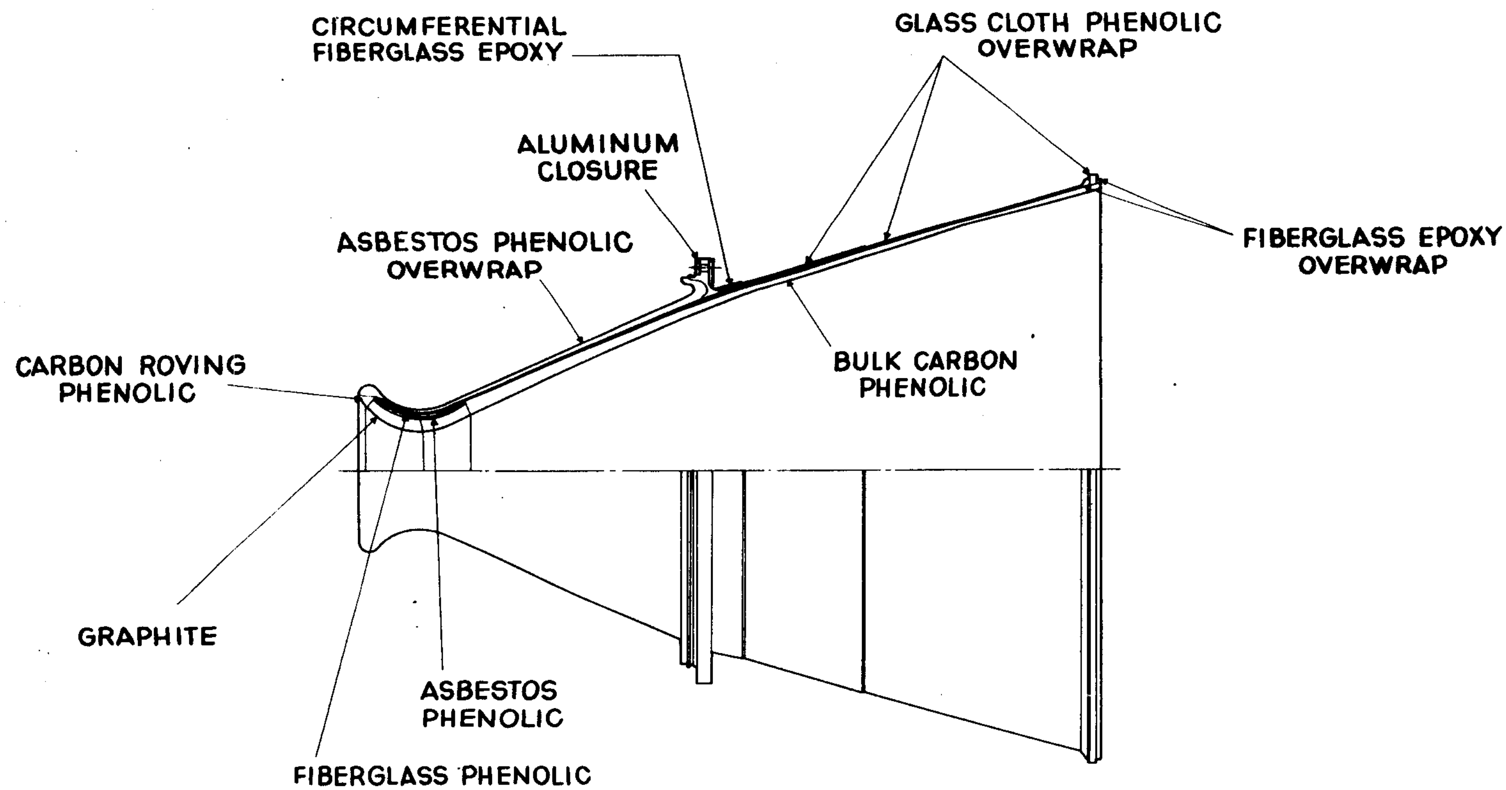
DISADVANTAGES of 1 JAN DESIGN BACKUP CHAMBER
(AND POTENTIAL PROBLEM AREAS)

- FLIGHT CONTROL LOGIC CHANGE (NO WEIGHT CHANGE)
- MOUNTING BRACKET REDESIGN
- POSSIBLE ROLL ACTUATOR INTERACTION
- POTENTIAL THROAT EROSION PROBLEM
- POTENTIAL RESPONSE AND HYSTERESIS LIMITATIONS

SPACECRAFT MARGINALITY

- DESCENT TRAJECTORY LIMITED BY
  VERNIER THRUST LEVEL
- IGNITION ALTITUDE LIMITED BY
  AMR & RADVS SENSITIVITY
- SPACECRAFT BALANCE LIMITED BY
  PAYLOAD LOCATION & THRUST MALALIGNMENT
- LANDING ACCURACY LIMITED BY
  CENTAUR FOM &/OR VERNIER PERFORMANCE

FLIGHT NOZZLE

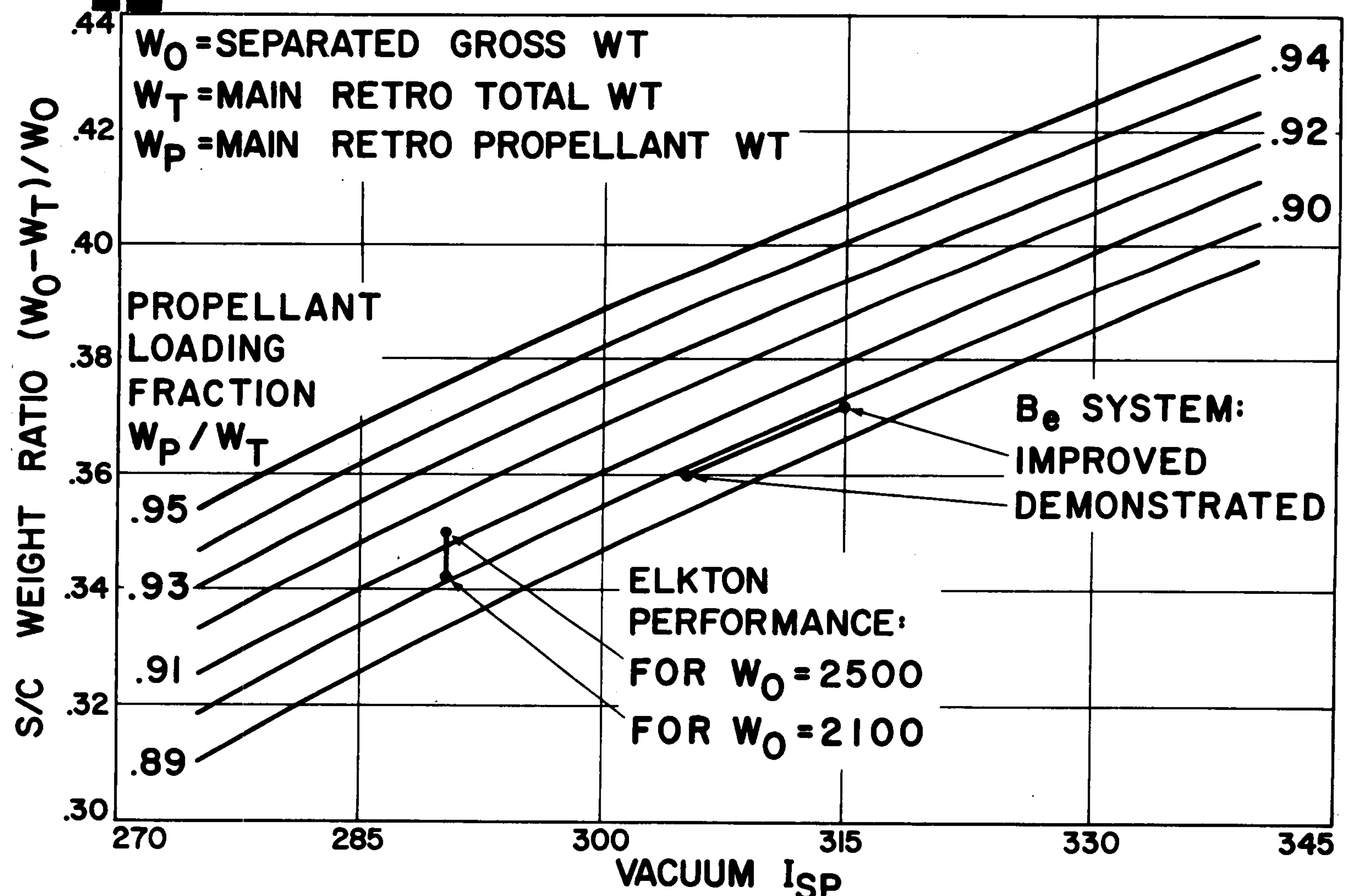


FLIGHT WEIGHT NOZZLE TEST SUMMARY

ENGINE NO.	TEST DATE	TEST ALTITUDE, ft	NOZZLE INSERT CONFIGURATION	ACTION TIME, sec	SPECIFIC IMPULSE I_{sp} (VAC), sec	RESULTS
A-21-4	2-22-63	SEA LEVEL	NO. 1, ZTA GRAPHITE	NOT AVAILABLE	NOT AVAILABLE	INSERT FAILED AT 1.3 sec FROM THERMAL SHOCK
A-25-8	3-22-63	SEA LEVEL	NO. 2, AHDG GRAPHITE	45.95	NOT AVAILABLE	SATISFACTORY
A-21-5	3-27-63	72,000	NO. 2, AHDG GRAPHITE	40.96	289.6	SATISFACTORY
A-21-9	4-12-63	130,000	NO. 2, AHDG GRAPHITE	NOT AVAILABLE	NOT AVAILABLE	INSERT FAILED AT 8.8 sec BECAUSE OF GRAPHITE QUALITY, OR GAS EVOLUTION BEHIND INSERT
A-21-6	5-8-63	75,000	NO. 3, TS-325 GRAPHITE	41.96	291.6	PERFORMANCE SATISFACTORY; INSERT CRACKED DURING FIRING.
A-25-13N	7-31-63	SEA LEVEL	NO. 4, TS-325 GRAPHITE	NOT AVAILABLE	NOT AVAILABLE	NOZZLE ASSEMBLY EJECTED @ 34.7 sec.
A-25-14N	7-25-63	SEA LEVEL	NO. 5, TS-325 GRAPHITE	NOT AVAILABLE	NOT AVAILABLE	PERFORMANCE SATISFACTORY; INSERT CRACKED
A-25-15N	8-28-63	SEA LEVEL	NO. 6, GRAPHITE GX	—	—	—
A-25-16N	10-9-63	VACUUM	WILL BE DETERMINED AFTER TESTS OF CONFIGURATION NOS. 4, 5, AND 6	—	—	—
A-25-17N	10-16-63	VACUUM		—	—	—
A-25-18N	10-23-63	VACUUM		—	—	—

[redacted]

PAYLOAD EFFECTS OF MAIN RETRO PERFORMANCE



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AVAILABLE PROPELLANTS
for
SURVEYOR APPLICATION

	Present Surveyor - Al	Aerojet - Be	Atlantic Research - Be
Polymer System	PBAA	Nitro-P.U.	P.U.
Specific Impulse, Sec. at Vacuum	290	306	306
Density, lbs/in^3	0.063	0.061	0.061
Burning Rate, in/sec. at 500 psia	0.229	0.290	0.230
Flame Temperature, OK	3319	3733	3550

[redacted]

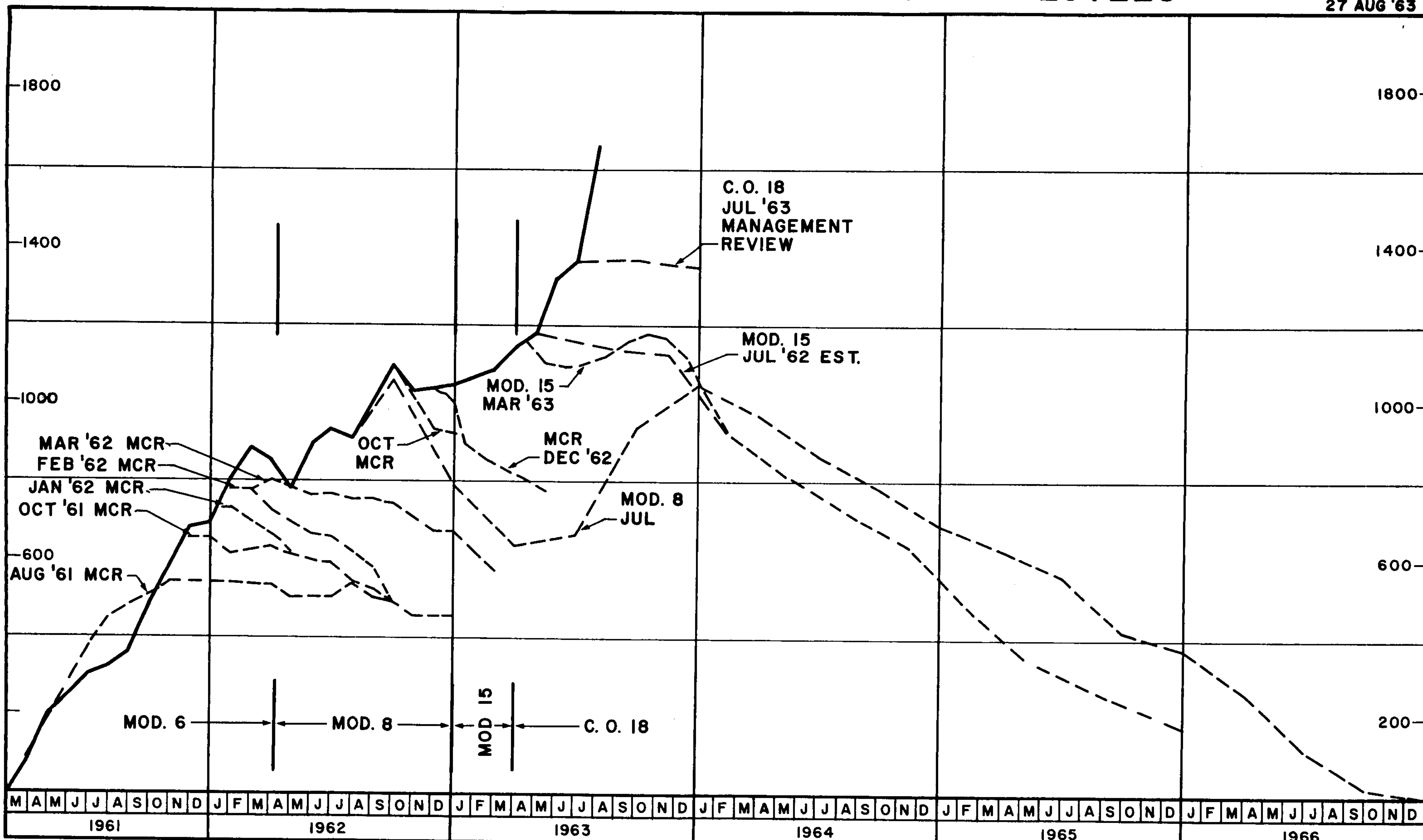
21-A CONFIGURATIONS

23 August 1963

Configuration	Payload	Basic Bus	Vernier Propellant	Main Retro Propellant	Total Separated Weight	Remarks
A	107	681	162	1266	2216	
A^1	107	683	163*	1269	2222	*New Tanks
B	98	681	159	1250*	2188	*Max. On-loading
C	83	681	156	1222	2142	
D	69	681	151	1199	2100*	*Basic Requirement
X	65	681	155	1199	2100	I_{sp} = 284 sec.

H A C EQUIVALENT NUMBER OF DIRECT EMPLOYEES

27 AUG '63



August 1963

CONTRACT 950056, SURVEYOR SPACECRAFT SYSTEM
Summary of All HAC CPFF Subcontracts
(X$1,000)

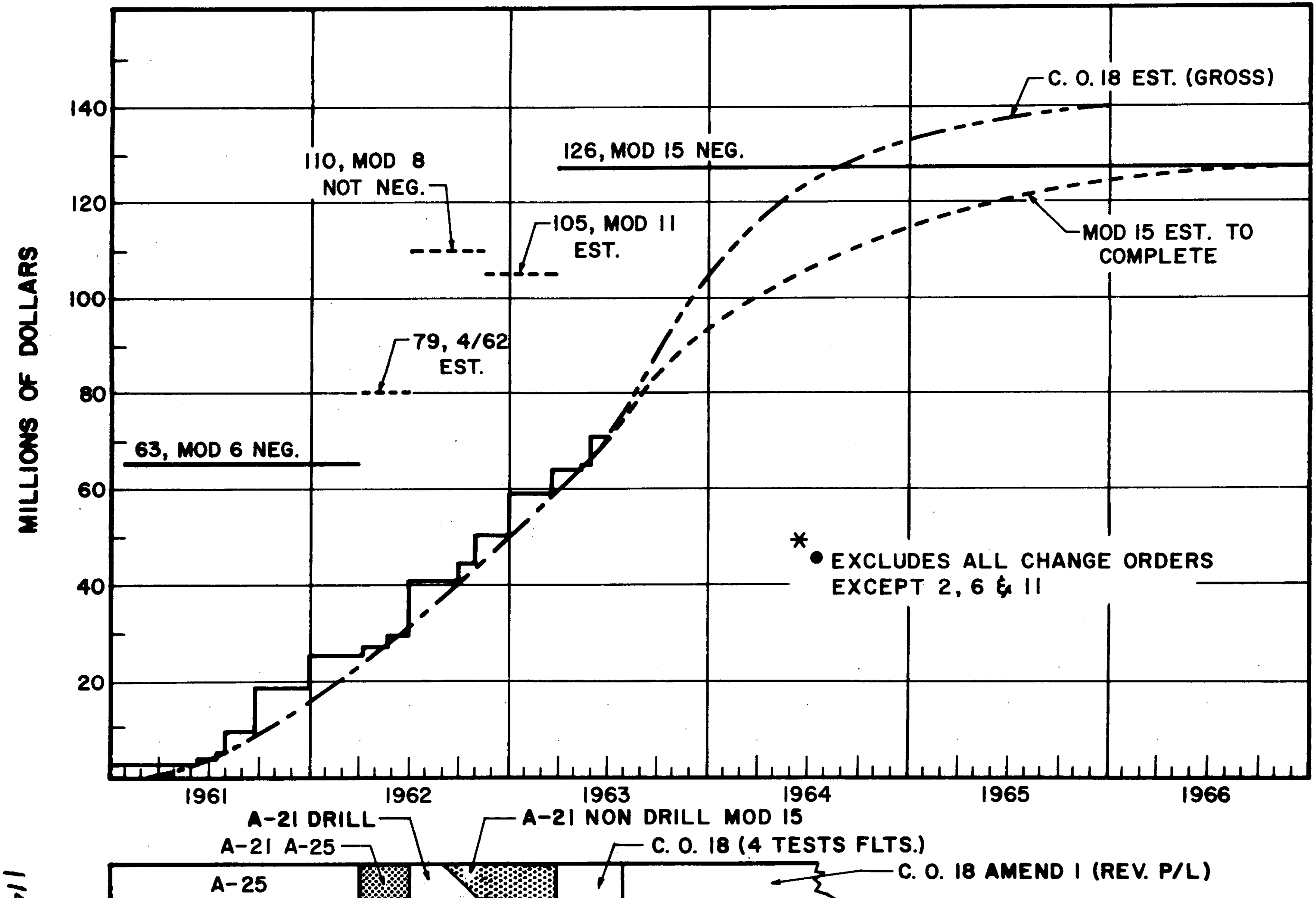
Subcontractor	Product	HAC Estimate for Definitive Contract	Subcontract Details: Original Contract	Subcontract Details: Current Contract	Subcontract Details: Current Estimate to Completion
Bell & Howell	Variable Length Lens	Not Separable	358	346	555
Bell & Howell	Fixed Length Lens	Not Separable	75	68	75
*Consolidated Electrodynamics	Tape Recorders	410	629	640	500
Electric Storage Battery Company	Batteries	291	264	432	550
*Electro-Optical Systems, Inc.	Ionization Chambers	Not then Included	184	152	176
*Harvey Aluminum	Anchoring Devices	Not Separable	52	52	30
*Lear Siegler	Drill Drive Heads	Not Separable	111	27	30
National Water Lift Company	Shock Absorbers	190	190	342	500
Ryan Electronics	Radar Altimeters	2,150	2,288	5,014	5,800
Thiokol Chemical Co. Elkton Division	Main Retro Rockets	2,927	2,806	4,654	6,280
Thiokol Chemical Co. RMD Division	Vernier System	2,380	2,377	6,800	9,000

NOTES: 1. All Subcontracts marked (*) are in process of termination (not required in current payload).

2. Increases in amounts under "Subcontract Details" are attributable to (i) change from 2,500 pound configuration to a combination of 2,500 pound and 2,100 pound configurations, (ii) change to all 2,100 pound configuration, (iii) rescheduling of Surveyor Spacecraft launch dates (stretchout), (iv) additional program redirection, especially Modification 15 and Change Order 18, and (v) technical problems, not foreseen at the time of initial negotiations between HAC and Subcontractors, leading to overruns.

SURVEYOR SPACECRAFT COST-TO-COMPLETE *

G & A LEVEL



CONTRACT 950056 HISTORY

Contract	Eff. Date	Purpose	Period	Funds Allotted X1000	Cumul Total X1000	Cost	Negotiated Fee	Total
LC	3-1-61	Initiation of Effort	6-13-61	2,350	2,350			-----
Mod. #1	3-24-61	Addt'n of Small Bus. Provision	6-13-61	-----	2,350			-----
Mod. #2	6-7-61	Extend Period of performance	7-14-61	1,150	3,500			-----
Mod. #3	7-12-61	Extend Period of performance	9-29-61	1,500	5,000			-----
Mod. #4	7-27-61	Extend Period of performance	9-29-61	4,750	9,750			-----
Mod. #5	8-31-61	Extend Period of performance	9-29-61	3,250	13,000			-----
Mod. #6	9-25-61	Definitive Contract	12-31-61	6,500	19,500	63,363,676	4,435,457	67,799,133
Mod. #7	12-28-61	Revises Provisions only	6-30-62	8,500	28,000	"	"	"
Mod. #8	4-5-62	Revises Scope - 5/2100#, 2/2500# - 1 Flight Ready Spare early 4th quarter CY 1963 first launch	6-30-62	2,200	30,200	"	"	"
Mod. #9	5-23-62	Adjustments for Change Orders 1 thru 7, increase in scope per Change Orders 8 and 9	6-30-62	2,200	32,400	63,431,592	4,440,211	67,871,803
Mod. #10	7-2-62	Increase in Scope CO's 7 & 10	7-15-62	1,300	33,700	"	"	"
Mod. #11	7-13-62	Increase in Funding & Extension of Period	9-30-62	10,000	43,700	"	"	"
Mod. #12	10-8-62	Same as Mod. #11	10-31-62	4,000	47,700	"	"	"
Mod. #13	11-6-62	Same as Mod. #11	12-31-62	6,000	53,700	"	"	"
Mod. #14	12-27-62	Same as Mod. #11	3-31-63	9,000	62,700	"	"	"
Mod. #15	1-28-63	Revises Scope - total redirection - recognizes CO #11 - 7/2100# no separate spare S/C first launch late 3rd quarter CY 1964 - defines new payload, etc.	3-31-63	-----	62,700	63,449,331	4,441,453	67,890,784
Mod. #16	3-26-63	Increases Funding & Extends Period for such funding	5-15-63	5,191	67,891	"	"	"
Mod. #17	5-10-63	Increases Est. Cost, Fixed Fee and Total Amount Allotted in recognition of equitable adjustments for certain Change Orders	5-15-63	798	68,688	64,196,876	4,491,499	68,688,375
Mod. #18	6-5-63	Increases Funding & Extends Period fr such funding	6-30-63	7,212	75,900	71,408,501	"	75,900,000
Mod. #19	7-23-63	Increases Funding & Extends Period for such funding	8-15-63	7,650	83,550	79,058,501	"	83,550,000

CONTRACT 950056 HISTORY (Cont'd)

Contract	Eff. Date	Purpose	Period	Funds Allotted X1000	Cumul Total X1000	Negotiated Cost	Negotiated Fee	Negotiated Total
Mod. #20	8-27-63	Increases Funding & Extends Period for such funding	9-30-63	6,000	89,550	85,058,501	"	89,550,000
C.O. #18		Redirection to provide for; planning for Dynamic Models (ordered via CO #25); 4 Test Flight S/C with Engineering Payload; creation of a T-21A Proof Test Model; Scientific Payload on last 3 S/C in accordance with Mod. #15; compressed launch schedule	4-1-63					
C.O. #18 Amend. #1		Redirection to: change Engineering Payload for 1st 4 S/C; change Scientific Payload for last 3 S/C	8-2-63					

CONTRACT 950056 CHANGE ORDER SUMMARY

C.O. No.	Description	Issue Date	Cost	Fee	Total	Status - Remarks
1	Study - Surveyor Follow-on Planning	9-11-61	24,609	1,050	25,659	Complete - Costs & Fee are Final
2	Centaur-to-Spacecraft Adapter	9-19-61	----	----	----	Costs are included in Mod. 15 Proposal
3	Lightweight Surveyor "A" Study	12-29-61	45,447	5,600	51,047	Complete - Costs & Fee are Final
4	Study - Alpha Particle Scattering Device	1-23-62	2,405	175	2,580	Complete - Costs & Fee are Final
5	Study - Petrographic Microscope	3-2-62	1,311	339	1,650	Complete - Costs & Fee are Final
6	Complete Definition of Task 12	3-8-62	----	----	----	Costs are included in Mod. 15 Proposal
7	Surveyor "B" Study	3-9-62	280,888	15,265	296,153	Complete - Costs & Fee are Final
8	Ionization Chamber Procurement	3-15-62	215,018	15,051	230,069	Complete - Costs & Fee are Final
9	Physical Parameters Instruments	4-17-62	13,469	915	14,384	Complete - Costs & Fee are Final
10	Systems Analysis Effort - Task 3	5-21-62	35,647	2,650	38,297	Complete - Costs & Fee are Final
11	S-Band Receiver Frequency Change	8-14-62	----	----	----	Costs are included in Mod. 15 Proposal
12	Study - Thermal Control, Alpha Particle Scattering Experiment	10-15-62	795	55	850	Complete - Costs & Fee are Final
13	Study - Advanced Flight Control Electronics	12-27-62	8,411	589	9,000	Complete - Amounts shown based on Cost Proposal - subject to Closure Adjustments
14	S-Band Receiver Frequency Change	2-11-63	560,955	46,523	607,478	In Process - Amounts shown based on Cost Proposal
15	Study - Surveyor Night Landing	2-21-63	11,762	812	12,574	Complete - Amounts Shown based on Cost Proposal - subject to Closure Adjustments
16	TV Photometric Calibration Charts	3-1-63	11,729	821	12,550	In Process - Amounts shown based on Cost Proposal
17	Vehicle/Adapter Interface Bolt Circle	3-1-63	8,509	596	9,105	In Process - Amounts shown based on Cost Proposal
18	Program Redirection	4-1-63		Indeterminate at this time		Proposal due late in September 1963 - will include Amendments 1 and 2 to C.O.
19	Study - DSIF Reqmt. for 1st Acquisition to Spacecraft under Direct Ascent Trajectory	4-2-63	15,840	1,169	17,009	Complete - Amounts shown based on Cost Proposal - subject to Closure Adjustments
20	Revision to X-Ray Diffractometer Spec.	4-2-63	12,660	886	13,546	Terminated 2 August 1963 - Amounts shown based on Cost Proposal - subject to Termination Adjustments
21	Revision to Soil Mechanics Instrument Spec.	4-2-63	4,402	308	4,710	Terminated 2 August 1963 - Amounts shown based on Cost Proposal - subject to Termination Adjustments
22	Revision to Alpha Scattering Expmt. Spec.	4-2-63	25,931	1,815	27,746	Amended 31 July 1963 - Amounts shown based on Cost Proposal for CO as issued

CONTRACT 950056 CHANGE ORDER SUMMARY (Cont'd)

C.O. No.	Description	Issue Date	Cost	Fee	Total	Status - Remarks
23	Revision to Surface Sampler Spec.	4-11-63	0	0	0	In Process - work to be accomplished at no increase in cost to Contract
24	Redesign of Flight Control Programmer/Flight Control Electronics	4-22-63	301,695	21,119	322,814	In Process - Amounts shown based on Cost Proposal
25	Spacecraft Dynamic Models	5-13-63		Indeterminate at this time		In Process - Cost Proposal due late in August
26	Revision to X-Ray Diffractometer Spec.	6-14-63	810	57	867	Terminated 2 August 1963 - Amounts shown based on Cost Proposal - subject to Termination Adjustments
27	Revision to Surface Sampler Spec.	6-14-63	0	0	0	In Process - work to be accomplished at no increase in cost to Contract
28	CDC-DSIF System Testers	6-28-63		Indeterminate at this time		In Process - Cost Proposal now overdue from HAC
29	Residents Effort at JPL, Orbit Determination	7-9-63	43,211	3,025	46,236	In Process - Amounts shown based on Cost Proposal
Totals, CO's 1 thru 17 less 2, 6, 11, 14 and 16			648,271	43,097	691,368	All CO's except 14 & 16 have been funded, but such amounts must be added to Mod. 15 costs & fees; note however, that CO's 2, 6 & 11 are already included in Mod. 15 costs.
Totals, CO's 14, 16, 18 thru 29, less 18, 25, and 28			977,233	75,723	1,052,956	Represents additional 'new' funding to Contract over and above Mod. 15 Costs.
Totals, all CO's except 2, 6, 11, 18, 25 and 28			1,625,504	118,820	1,744,324	These totals represent 'additions' to Mod. 15 Costs & Fee.

CONTRACT 950056, COMPARATIVE ANALYSIS

MODIFICATION NOS. 6, 8 and 15

The following is submitted for purely informational purposes to denote the "growth" of subject Contract costs. All fiscal entries are for the total program authorized by each of the Modifications, all beginning at 1 March 1963, and, within Mod. #15, excluding all Change Orders except 2, 6 and 11.

A. Labor Hours

Task No.	Modification #6	*Modification #8	Modification #15
1	189,779	261,123	416,123
2	60,457	49,557	72,535
3	185,966	195,862	270,097
4	96,869	123,172	103,545
5	450,640	930,250	1,466,942
6	112,864	186,592	381,603
7	56,107	55,162	81,639
8	97,687	120,303	156,668
9	264,257	546,024	846,280
10	136,757	176,246	274,269
11	210,910	322,106	461,688
12	5,810	10,546	19,571
13	639,350	1,060,006	1,243,615
14	524,360	908,481	1,028,386
	3,031,813	4,945,430	6,822,961

NOTE: * = excludes period 1 March 1961 through 11 March 1962

B. Labor Cost (includes overhead and LCV (Labor Cost Variance), but excludes G & A expense and Fee)

Task No.	Modification #6	Modification #8	Modification #15
1	$ 2,728,994	$ 4,557,587	$ 5,675,465
2	672,984	581,081	716,990
3	3,094,001	3,269,331	3,909,615
4	1,561,894	1,880,821	1,434,534
5	5,943,864	12,044,345	14,307,265
6	1,324,463	3,055,735	4,194,958
7	867,920	881,456	1,012,953
8	1,258,432	1,615,697	1,629,013
9	3,491,022	6,909,257	8,303,880
10	1,889,344	3,051,224	3,341,394
11	2,285,860	4,021,132	4,450,747
12	91,580	312,468	284,860
13	8,689,120	13,620,661	13,755,630
14	7,266,838	11,874,754	12,518,427
	$41,165,716	$67,675,549	$75,535,731

C. Material (does not include G & A expense nor Fee)

Task No.	Modification #6	Modification #8	Modification #15
1	47,000	63,156	151,364
2	900	55,776	593,848
3	---	339	3,068
4	---	6,428	4,438
5	2,034,739	3,507,400	4,292,410
6	40,200	211,676	217,981
7	---	124,750	108,822
8	33,110	119,558	117,016
9	32,600	491,030	971,487
10	185,994	111,013	261,267
11	85,000	631,275	898,199
12	---	2	823
13	1,621,550	2,977,691	2,971,356
14	379,000	735,174	680,756
	4,410,093	9,035,268	11,272,835

D. Subcontracts (does not include G & A expense nor Fee)

Task No.	Modification #6	Modification #8	Modification #15
1	---	17,970	---
2	---	335,330	---
3	---	---	---
4	---	---	---
5	2,560,000	5,033,414	6,578,200
6	940,500	1,457,962	1,943,184
7	5,306,900	9,183,348	12,136,133
8	686,000	755,901	848,340
9	179,500	975,638	450,383
10	189,954	422,198	456,340
11	171,000	571,730	143,634
12	---	---	---
13	75,000	487,425	188,953
14	1,412,500	2,293,266	1,804,478
	11,521,354	21,534,182	24,549,645

E. Travel (does not include G & A expense nor Fee)

Task No.	Modification #6.	Modification #8	Modification #15
1	85,278	14,220	70,788
2	---	---	---
3	28,810	25,114	26,520
4	117,590	103,864	40,881
5	8,578	40,264	65,305
6	7,140	14,737	33,041
7	61,200	80,047	110,694
8	22,950	33,902	36,485
9	15,687	34,945	60,545
10	22,140	24,116	28,117
11	14,760	17,281	9,801
12	10,613	23,200	34,936
13	139,376	206,355	237,124
14	683,308	905,854	708,735
	1,217,430	1,523,899	1,462,972

F. Special Tools and Test Equipment (Does not include G & A expense nor Fee)

Task No.	Modification #6	Modification #8	Modification #15
1	---	---	---
2	---	200	1,042
3	---	---	---
4	---	---	206,073
5	57,065	409,000	672,959
6	18,500	15,500	143,685
7	---	200	323
8	10,000	9,000	17,390
9	6,500	---	360,588
10	15,000	8,100	9,338
11	112,000	28,025	34,319
12	17,000	---	295
13	50,000	194,355	57,377
14	95,000	317,400	203,899
	381,065	981,780	1,707,288

G. Other

Task No.	Modification #6	Modification #8	Modification #15
1	---	3,220	9,191
2	---	---	---
3	---	---	---
4	---	---	18,119
5	---	2,100	14,225
6	---	5,000	---
7	---	---	---
8	---	2,500	6,400
9	---	---	19,425
10	---	1,500	3,600
11	---	---	---
12	---	---	---
13	21,318	610,389	214,981
14	138,588	226,186	328,179
	159,906	850,895	614,120

H. Task Totals (does not include G & A expense nor Fee)

Task No.	Modification #6	Modification #8	Modification #15
1	2,861,272	4,656,153	5,906,808
2	673,884	972,387	1,311,880
3	3,122,811	3,294,784	3,939,203
4	1,679,484	1,991,113	1,704,045
5	10,604,246	21,036,523	25,930,364
6	2,330,803	4,760,610	6,532,849
7	6,236,020	10,269,801	13,368,925
8	2,010,492	2,536,558	2,654,644
9	3,725,309	8,410,870	10,166,308
10	2,252,432	3,318,151	4,100,056
11	2,668,620	5,269,443	5,536,700
12	119,193	335,670	320,914
13	10,596,364	18,096,876	17,425,421
14	9,974,634	16,352,634	16,244,474
	58,855,564	101,601,573	115,142,591

I. Summary of above (does not include Fee)

Element	Modification #6	Modification #8	Modification #15
Labor Hrs.	3,031,813	4,945,430	6,822,961
Labor Cost	$41,165,716	$67,675,549	$75,535,731
Materials	4,410,093	9,035,268	11,272,835
Subcontracts	11,521,354	21,534,182	24,549,645
Travel	1,217,430	1,523,899	1,462,972
ST & STE	381,065	981,780	1,707,288
Other	159,906	850,895	614,120
Mfg. Cost	$58,855,564	$101,601,573	$115,142,592
G & A	4,508,112	8,851,641	10,602,853
Total (less Fee)	$63,363,676	$110,453,214	$125,745,445

With reference to Modification No. 15, all of the above data comes from the Cost Proposal as received on 11 March 1963. Paragraphs J and K below compare Mod. #15 data as Proposed and as Negotiated.

J. Task Totals (does not include G & A expense nor Fee)

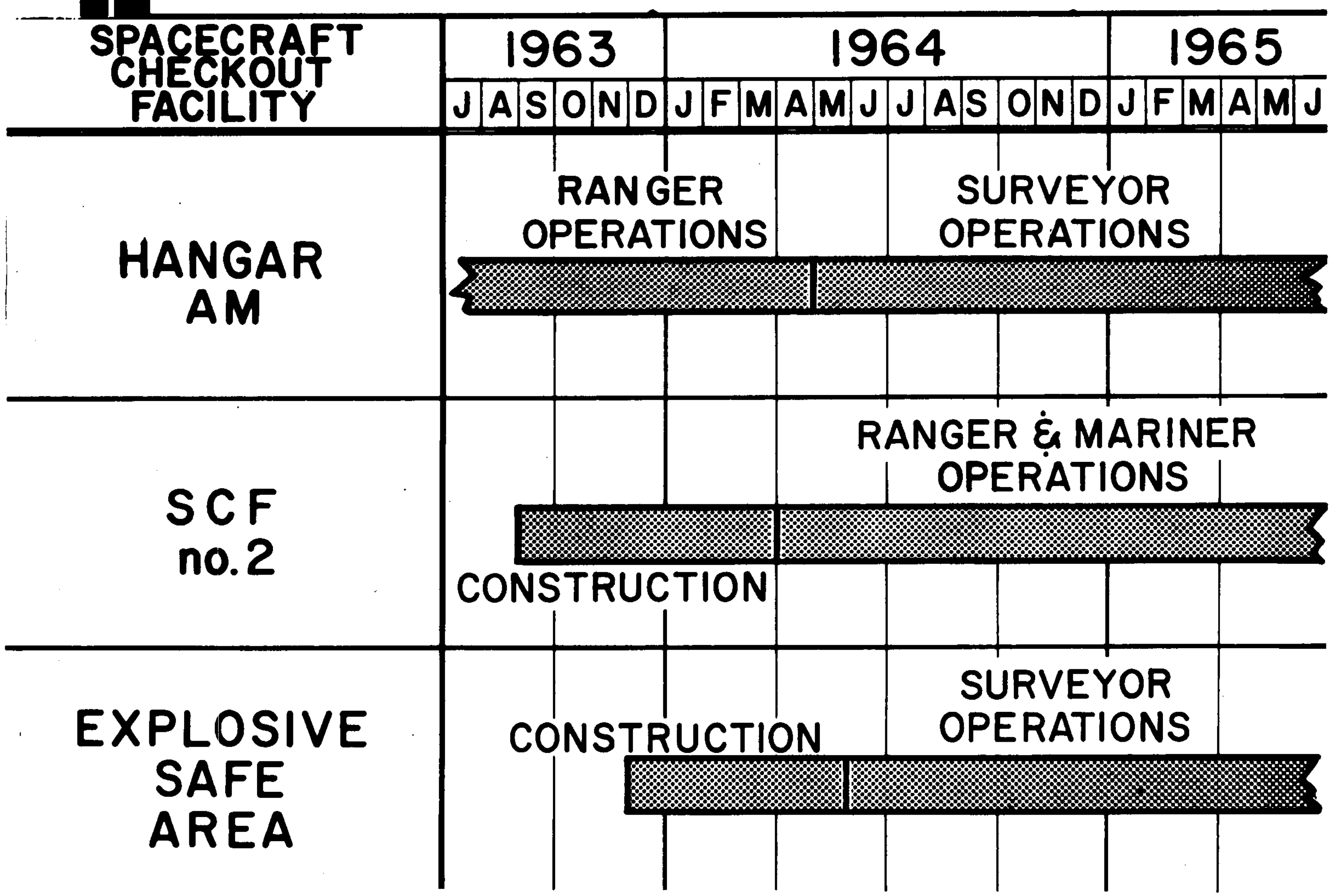
Task No.	Modification #15 Proposal	Modification #15 Negotiated
1	5,906,808	5,902,809
2	1,311,880	1,312,630
3	3,939,203	3,927,897
4	1,704,045	1,693,787
5	25,930,364	26,978,738
6	6,532,849	6,475,368
7	13,368,925	13,428,966
8	2,654,644	2,501,817
9	10,166,308	9,757,343
10	4,100,056	4,108,162
11	5,537,700	5,377,263
12	320,914	317,453
13	17,425,421	17,224,234
14	16,244,474	16,098,619
	115,142,591	115,105,086

K. Summary, by Element of Cost (does not include Fee)

Element	Modification #15 Proposal	Modification #15 Negotiated
Labor Cost	$75,535,731	$75,661,489
Materials	11,272,835	11,200,836
Subcontracts	24,549,645	24,604,439
Travel	1,462,972	1,234,802
ST & STE	1,707,288	1,797,379
Other	614,120	606,141
Mfg. Cost	$115,142,592	$115,105,086
G & A	10,602,853	10,599,359
Total (less Fee)	$125,745,445	$125,704,445

To the Mod. #15 Negotiated Totals, must be added the costs of all Change Orders except 2, 6 and 11.

SURVEYOR AMR FACILITIES SCHEDULE



8-23-63

SURVEYOR LANDER FY-64 RECAP

Item	6-24-63 Presentation to Headquarters	8-23-63 C.O. #18 Schedule	8-23-63 Plan 1 Program (4 Mo. delay)
Project Management	2.952	2.952	2.952
Science	4.529 (reduce SM1 by 0.5M)	4.00	3.500
SFOF & Video	5.653 (Inc. 1.5M video)	5.653	4.400 (0.3 video)
S/C System	45.770	54.10 (Inc. C.O. #18 Amend. 1)	45.000
Sub Total	58.904	66.705	55.852
Launch Vehicle	46.800	47.950 (Per LeRC on 8-21-63)	36.300 (Inc. Conting.)
Surveyor Block I Total	105.704	114.655	92.152
Surveyor Block II	5.016	5.016	1.848
	110.720	119.671	94.000

SURVEYOR PROGRAM PLAN COMPARISON